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Report: AQRB-83-002-L

The Kettles Hill Experiment -
Site Description and Mean Flow Results

by

P.A. Taylor, R.E. Mickle, J.R. Salmon*
and H.W. Teunissen**

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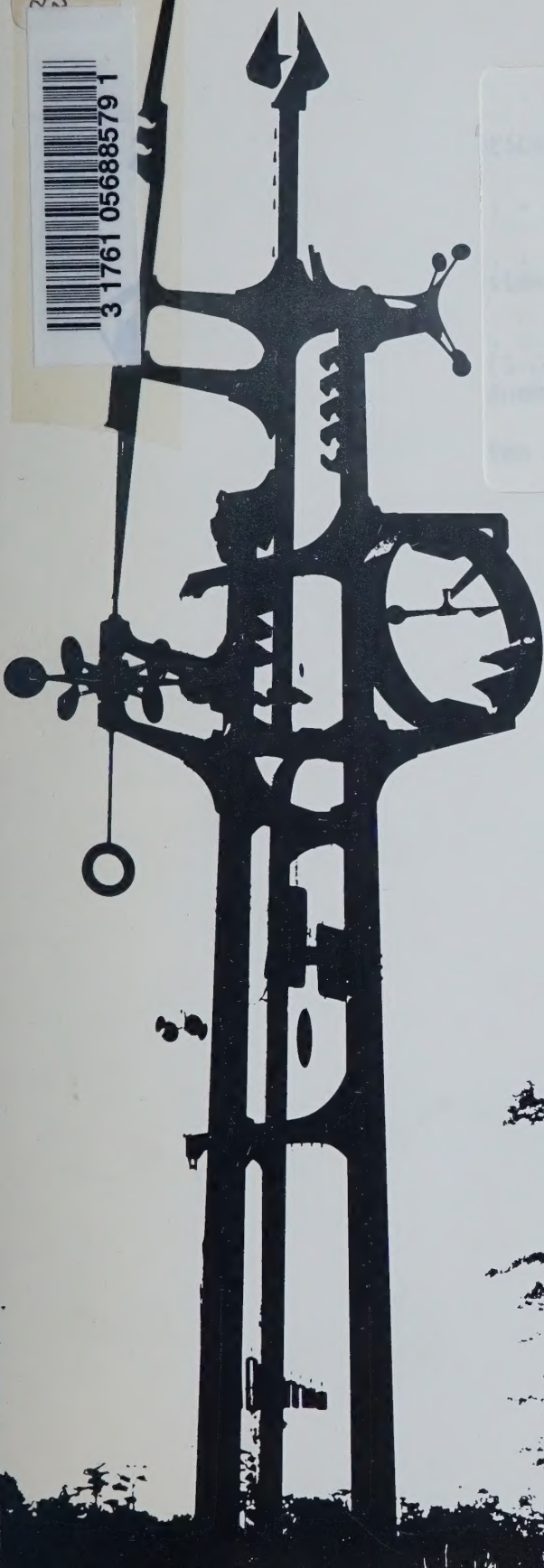


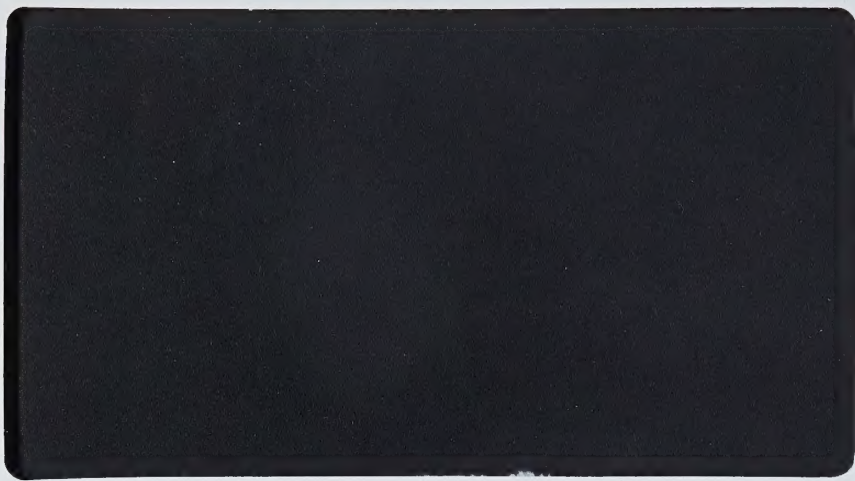
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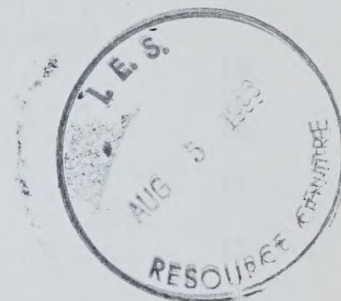
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P.A. Taylor, R.E. Mickle, J.R. Salmon*
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Date Completed: March 1983



This is one of a series of internal reports prepared in the Atmospheric Research Directorate. It is an unpublished manuscript.

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1. INTRODUCTION

The Kettles Hill Experiment was a field study of boundary layer flow over an isolated low hill. It was undertaken in February 1981 as part of a continuing programme to improve our understanding of flow in complex terrain. A specific aim of the experiment was to measure the perturbations in mean wind speed and direction with sufficient spatial resolution to allow detailed comparisons with the predictions of theoretical (Salmon et al., 1981; Walmsley et al., 1982) and wind tunnel (Teunissen and Flay, 1981; Teunissen et al., 1982) models of the same flow. Turbulence measurements were also made. In addition to its inherent scientific interest this type of study has applications for wind energy site selection, estimation of wind loads on structures and pollutant dispersal in complex terrain.

The site for the experiment, just east of Pincher Creek, Alberta was chosen after a fairly extensive nationwide search (see Taylor et al., 1980). The hill and site criteria included relative isolation in otherwise flat terrain, uniform surface cover or roughness (but excluding wooded hills, due to the difficulty of making representative near-surface measurements), a mean slope of about 0.2, high local winds and a simple shape without too much terrain microstructure. The logistics of mounting an experiment at the site were also considered. A brief visit and preliminary measurements were made in February 1980 to confirm the suitability of Kettles Hill and, after consideration of the wind climatology of the area, February 1981 was selected as a suitable time for an intensive four-week field study.

A total of twenty-one meteorological towers were used in the experiment. Ten 10m towers were equipped with 3-cup anemometers at 3m and 6m and three-component propeller anemometers at the 10m level. A sonic anemometer was used for additional measurements at the 10m level at the hill summit. One 10m tower was used for 'routine' meteorological measurements near the top of the hill using a standard Atmospheric Environment Service U2A cup-and-vane anemometer system and the remaining ten 3m towers were equipped with 3-cup pulse-type anemometers. An automatic weather station was also deployed and some AIRsonde flights were made to determine temperature profiles. The towers were placed on and upwind of the hill.

We had planned to complement the near surface measurements with parafoil-supported tethered profiles of wind speed and temperature to heights of several hundred metres at the hilltop and in the undisturbed upstream flow. However, in spite of several attempts, we found we were unable to maintain the parafoil in stable flight in the wind speeds ($10 - 20 \text{ m s}^{-1}$ near the ground) encountered during the observation periods. A return visit in February 1982 was only partially successful and we are at present attempting to improve our kite-flying capabilities.

Data were collected during a number of 2-6 h runs in fairly steady, moderate-to-high wind situations with near-neutral stratification. The 10m tower data were digitized at 2 Hz or 4 Hz on SEADATA loggers and the run-of-wind from the 3m towers was recorded at 10 or 15 min intervals.

There have been a number of previous field studies of boundary-layer flow over hills. In particular, recent studies have included those by Mason and Sykes (1979) at Brent Knoll, Sacré (1979) near Pouzauges, Bradley (1980) at Black Mountain, and Jenkins et al. (1981) at Ailsa Craig. Topographically, Brent Knoll is probably the most similar to Kettles Hill but it does have some wooded areas and rather more microstructure. The present study is in many ways a natural evolution from Mason and Sykes' work. The theoretical model we have used, MS3DJH (see Walmsley et al., 1982) is an extension of their technique applied to 'real' terrain and the concept of measuring mean wind perturbations with good spatial resolution is the same. We will, however, make no appeal to axial symmetry of the terrain in our analysis of the results as it would clearly be inappropriate for Kettles Hill. As a consequence, we plan to base our main comparisons between theory and experiment on wind speed variations along lines of towers at specific positions on the hill. The 10m turbulence data collected have better horizontal resolution than other complex terrain studies of which we are aware.

In addition to serving as a self-contained study in its own right, the Kettles Hill Experiment acted as a thorough field trial for the Canadian component of an International Energy Agency (IEA) study of local wind flow at a potential WECS (Wind Energy Conversion System) hill site. The first phase of this collaborative experiment was conducted during September/October 1982 at Askervein Hill in the Outer Hebrides, Scotland.

2. KETTLES HILL - Site Description and Climatology

Kettles Hill (an unofficial name based on its ownership by Mr. & Mrs. E. Kettles) is located about 8 km east of the town of Pincher Creek, Alberta at $49^{\circ} 30' \text{ N}$, $113^{\circ} 50' \text{ W}$. Fig. 1 is copied from 1:50,000 National Topographic Maps of the area. Fig. 2 is a more detailed form-line map with contours at 1m separation and was produced from stereo photographic pairs specifically for our study. Winds in the area are predominantly from the West (see Table 1) so we chose to place the main emphasis of the experiment on variations along an E-W line through the summit of the hill. The height of the summit above the surrounding terrain, h , is approximately 100m and the elevation is about half that height at a distance of approximately 600m to the west of the summit, thereby producing a characteristic length 'L' of 600m for this direction. Fig. 3 is a photograph of the hill from the southwest. An E-W terrain cross-section is shown in Fig. 6.

During the instrumentation set-up period there was a light general snow cover with 30-40 cm of snow in some hollows. Two preliminary runs (Nos.0 & 1) were made with snow cover ($\sim 90\%$ and $\sim 60\%$) on 12 and 14 February. Approximately 10% snow cover remained during Run 2 on 15 February but from then on the surface was almost entirely low, brown-and-yellow grass and mud, both on the hill and in the surrounding terrain, as shown in Fig. 4. Some of the fields upwind were still slightly rutted from the previous year's ploughing but the surface roughness length was probably not significantly different from the rest of the terrain. Oke (1978) gives a roughness length for short grass ($< 10 \text{ cm}$) as 0.3 to 1 cm and suggests 0.1 to 1 cm for soil.

In an attempt to obtain an experimental estimate of z_0 , a small amount of profile data was collected at the end of the experiment on the hilltop and at the upwind reference tower using four levels of cup anemometry. Results are discussed in Section 4.2.

The maps and photos in Figs. 1 to 4 show that the hill is locally isolated and that there is a good flat, uniform, unobstructed fetch to the west. This extends for some 15 - 20, km beyond which are the foothills of the Rocky Mountains. There are major ridges (the Blairmore range and Barnaby ridge) about 50 km to the west of Kettles Hill which rise to around 2100m above sea level ($\sim 900\text{m}$ above Pincher Creek). Pincher Creek and Kettles

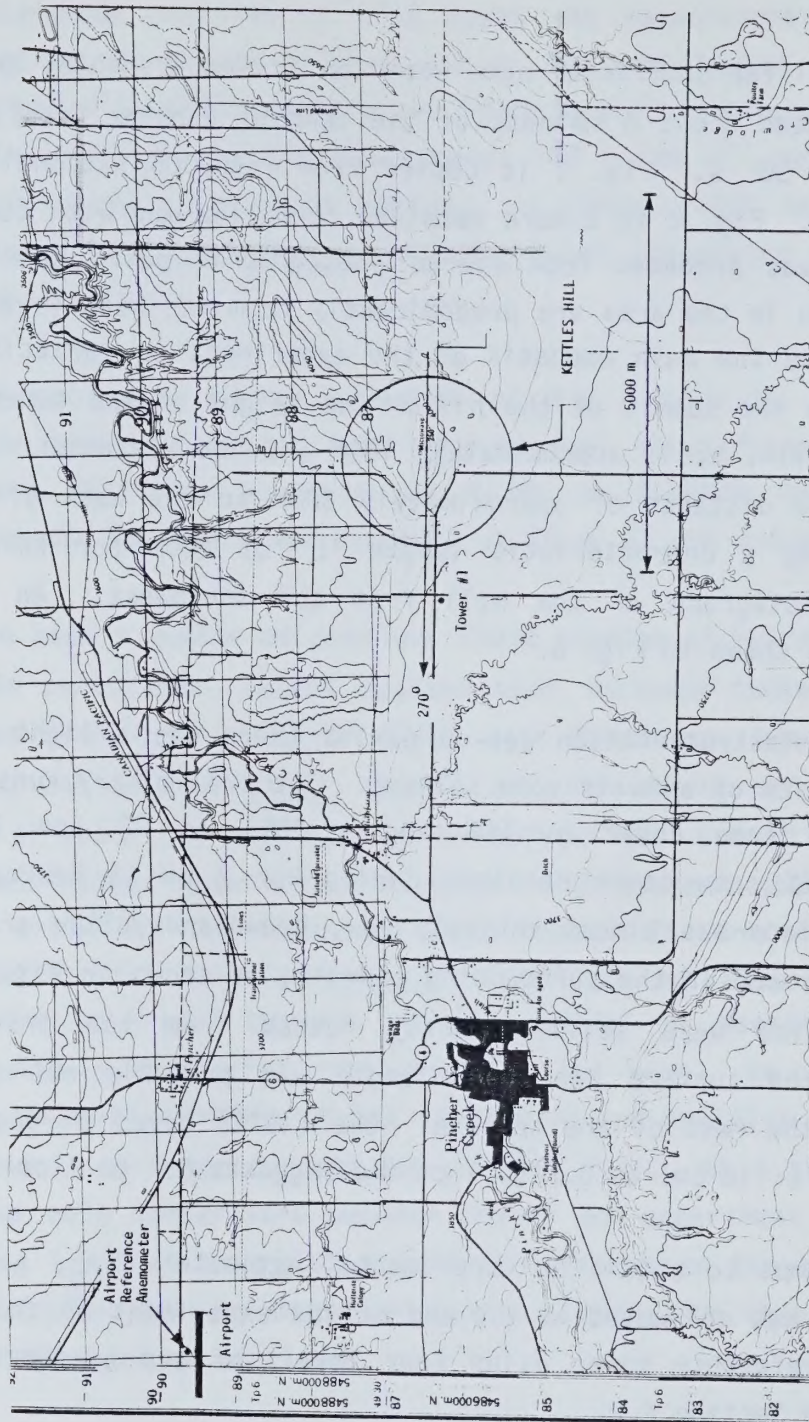


Fig. 1. Kettles Hill and environs near Pincher Creek, Alberta.
(contour interval 50 ft.)

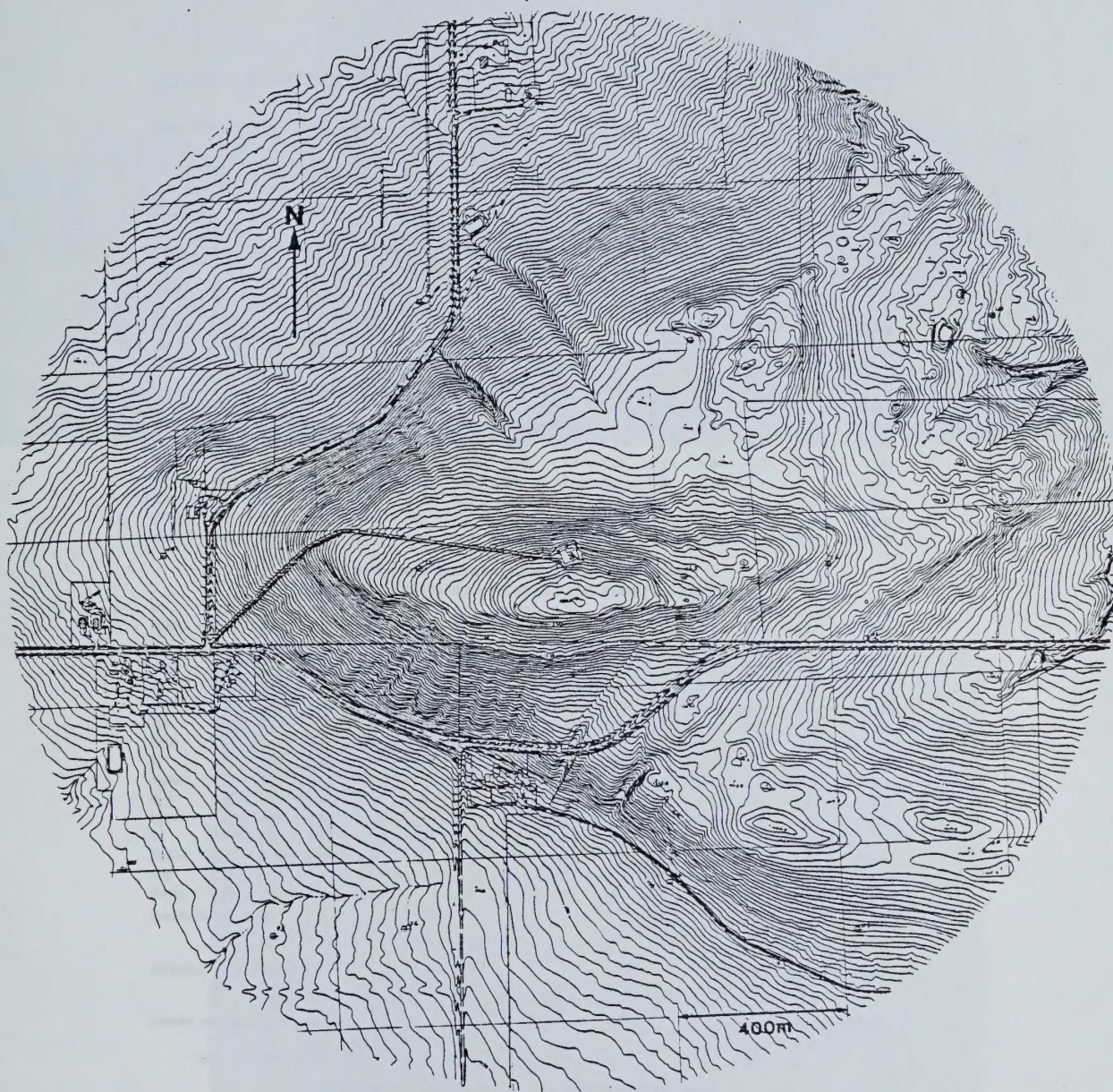


Fig. 2. Detailed form-line map of Kettles Hill. (Contour interval 1m)

Table 1 Wind statistics at Pincher Creek airport weather station - reproduced from Canadian Normals, Vol. 3, Environment Canada.

PINCHER CREEK ALTA.

PERIOD 1960-80 PERIODE

Lat. 49°30'N Long. 113°57'W

Elevation 1155 m Altitude

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	
	JANV	FEV	MARS	AVR	MAI	JUIN	JUIL	AOUT	SEPT	OCT	NOV	DEC	ANNUEL	
PERCENTAGE FREQUENCY	FRÉQUENCE EN %													
N	0.2	0.3	0.7	1.5	1.0	0.9	0.8	0.6	1.0	0.5	0.3	0.2	0.7	N
NNE	0.4	0.5	1.0	2.0	1.5	0.9	0.8	0.6	1.2	0.3	0.3	0.2	0.8	NNE
NE	1.4	1.2	2.2	2.8	2.6	2.1	2.3	2.0	2.2	1.3	1.0	1.0	1.8	NE
ENE	1.4	1.2	1.8	2.2	2.3	1.4	1.4	1.8	1.6	1.1	1.4	1.1	1.6	ENE
E	6.0	4.6	4.3	3.9	3.7	2.3	3.5	3.3	2.9	2.1	3.8	3.9	3.7	E
ESE	4.6	4.3	3.1	2.1	2.6	2.1	2.3	2.4	1.9	1.4	3.1	3.3	2.8	ESE
SE	3.3	2.7	2.6	2.4	2.6	2.3	2.9	2.3	2.0	1.3	2.3	3.2	2.5	SE
SSE	1.1	1.2	1.3	1.3	2.0	1.7	1.7	1.0	1.0	0.7	1.2	1.2	1.3	SSE
S	1.4	1.4	2.5	2.4	2.2	2.0	2.4	2.1	2.0	1.7	1.6	1.4	1.9	S
SSW	0.8	0.9	1.3	1.6	1.3	1.4	1.8	1.9	1.9	1.4	1.0	0.9	1.3	SSW
SW	3.8	3.9	5.5	6.5	6.7	6.5	8.8	8.6	7.4	6.1	4.8	3.4	6.0	SW
WSW	14.7	15.8	18.7	21.0	17.7	20.0	16.8	17.5	19.0	22.4	17.8	15.2	18.1	WSW
W	39.1	42.2	34.8	31.6	32.7	33.1	30.1	31.8	34.0	43.0	40.9	42.8	36.3	W
WNW	5.7	4.7	4.7	4.6	5.6	6.0	6.2	7.0	5.2	4.8	5.1	6.0	5.5	WNW
NW	0.9	1.0	1.2	1.6	2.6	2.5	1.9	2.0	1.9	1.2	0.8	0.9	1.5	NW
NNW	0.2	0.2	0.5	0.8	1.2	0.7	0.6	0.5	0.6	0.3	0.2	0.2	0.5	NNW
Calm	15.0	13.9	13.8	11.7	11.7	14.1	15.7	14.6	14.2	10.4	14.4	15.1	13.7	Calm
MEAN WIND SPEED IN KILOMETRES PER HOUR														
VITESSE MOYENNE DES VENTS EN KILOMETRES PAR HEURE														
N	11.3	13.0	13.9	16.7	12.5	13.8	10.4	11.2	13.7	11.4	9.4	8.3	12.1	N
NNE	15.0	17.6	16.6	16.7	16.5	16.6	15.1	11.2	13.2	12.0	12.1	10.9	14.5	NNE
NE	11.7	12.1	12.7	13.6	12.8	11.7	11.2	11.1	11.3	11.8	12.1	11.0	11.9	NE
ENE	11.7	12.5	12.5	11.4	11.8	12.1	11.7	10.3	11.2	11.5	11.8	11.7	11.7	ENE
E	10.1	9.7	10.0	10.0	10.8	9.8	9.9	9.1	9.1	10.0	9.8	9.8	9.8	E
ESE	10.6	10.6	9.8	10.2	11.0	10.6	10.3	10.6	8.7	9.5	9.4	9.8	10.1	ESE
SE	10.3	9.9	8.6	9.6	10.4	11.0	10.4	10.1	9.0	8.8	9.5	10.2	9.8	SE
SSE	11.2	10.9	9.7	10.9	11.0	12.3	11.5	10.0	9.5	9.5	9.9	9.8	10.5	SSE
S	9.2	9.6	11.1	12.0	11.0	11.2	10.6	10.4	9.2	8.9	9.2	11.1	10.3	S
SSW	11.5	11.3	11.3	13.2	13.4	12.5	12.5	12.9	11.7	12.1	13.0	11.2	12.2	SSW
SW	19.7	18.2	18.4	19.7	18.5	16.6	16.8	17.6	17.4	18.5	18.9	19.8	18.3	SW
WSW	36.1	34.1	29.4	30.3	26.4	26.3	22.6	23.5	25.6	31.2	30.8	32.9	29.1	WSW
W	35.7	33.0	28.6	27.7	24.5	24.0	21.7	21.4	24.4	30.2	31.2	32.6	27.9	W
WNW	19.8	17.4	15.7	14.8	14.7	15.7	15.0	13.6	15.1	17.5	19.0	20.5	16.6	WNW
NW	12.8	11.8	12.5	12.0	13.4	13.1	10.5	10.1	11.8	11.8	12.2	15.0	12.3	NW
NNW	11.8	12.1	12.2	13.5	16.9	14.1	11.3	11.2	13.7	14.6	11.4	14.5	13.1	NNW
All Directions	Toutes directions													
	23.5	22.9	19.7	20.1	17.9	17.6	15.2	15.5	17.4	23.3	21.9	22.7	19.8	
Maximum Hourly Speed	Vitesse horaire maximale													
W	137	109	109	93	80	90	72	89	90	106	135	122	137	
WSW	W	W	W	W	SW	W	W	WSW	W	WSW	WSW	WSW	W	
Maximum Gust Speed	Vitesse maximale des rafales													
W	161	150	153	138	138	130	116	132	117	154	177	161	177	
WSW	W	WSW	W	W	WSW	W	SVL	WSW	W	WSW	WSW	SVL	WSW	
Height of anemometer 8.8 m hauteur de l'anémomètre														

STATION INFORMATION

Station is located on high ground in the southwest corner of the town of Pincher Creek. From the instrument area the terrain slopes sharply down to the north and east to the Pincher Creek valley. To the south and west the country is rolling farms and ranchlands. Station relocated to airport June 1979.

DONNÉES RELATIVES À LA STATION

La station se trouvait sur une hauteur, au coin sud-ouest de la ville de Pincher Creek. Le terrain va en descendant abruptement de l'emplacement des instruments en direction du nord et de l'est vers la vallée de Pincher Creek. On trouve au sud et à l'ouest des terres arables et des pâturages ondulées. La station a été réinstallée à l'aéroport en juin 1979.

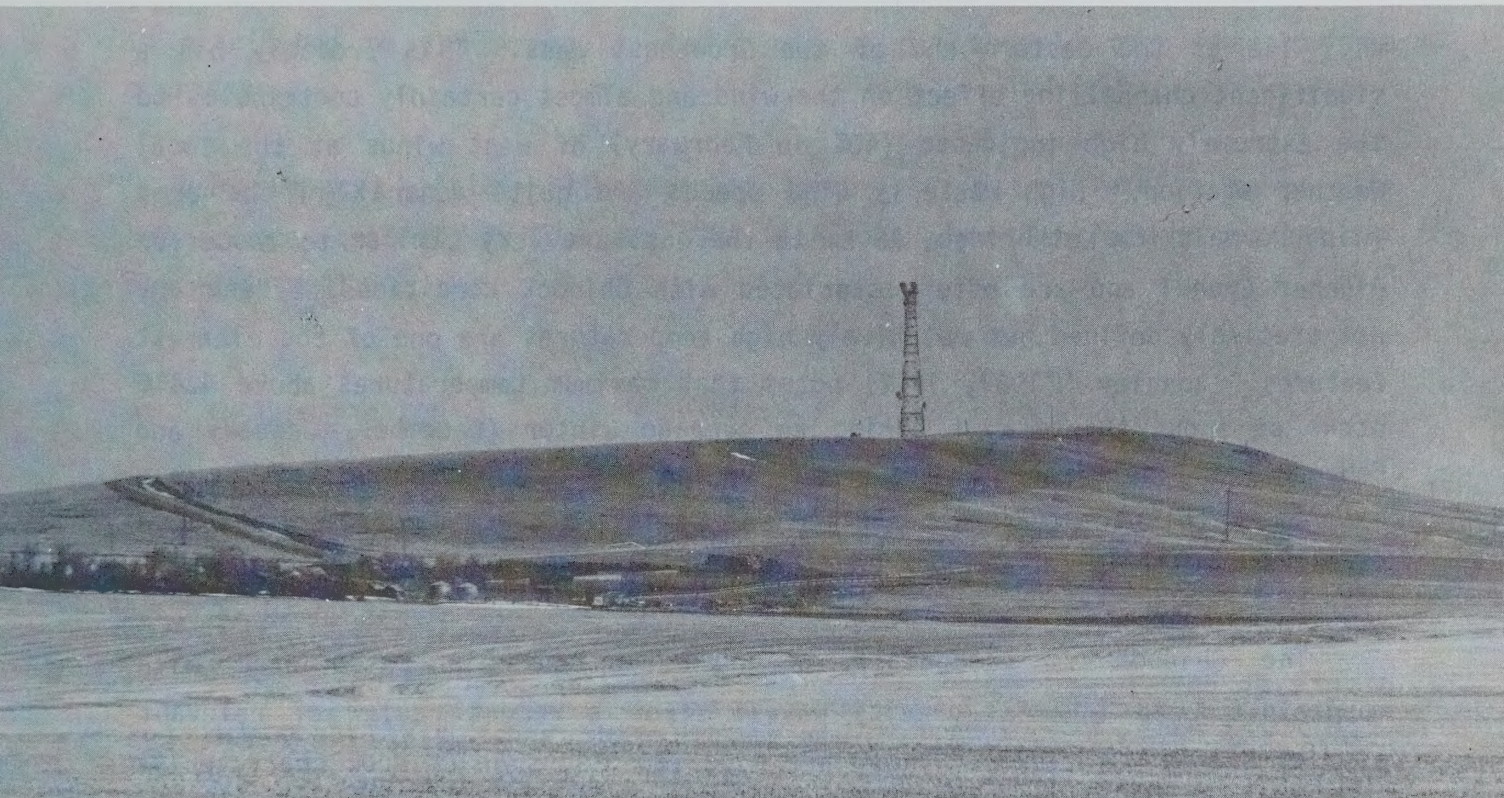


Fig. 3. Photo of Kettles Hill from South West.



Fig. 4. Photo of Hilltop Area.

Hill lie at the eastern end of the Crowsnest pass. This probably has a significant channelling effect on the wind and almost certainly contributes to the extremely high incidence (40% in February) of west winds at the local weather station. High westerly wind speeds are quite general in the area (wind normals for Lethbridge, 75 km to the east are very similar to those for Pincher Creek) and are often associated with Chinook conditions. These are not precisely defined but relatively high temperatures are one of the clearest features. Longley (1967, 1972) notes that maximum temperatures above 4.4°C occur on about thirty days during an average winter (December, January and February) in the Pincher Creek area. During the observation period for our experiment this temperature criterion was satisfied every day, the winds were strong and westerly and Chinook conditions are considered to have occurred.

The Chinook is essentially a dry downslope wind associated with mountain-induced internal gravity waves. (For a recent review of relevant studies see Lester, 1976). There are wide variations in Chinook characteristics but in general they are associated with gravity waves of length scale 50 - 100 km (see also Holmes and Hage, 1971). Evidence from satellite cloud photographs (Lester, 1976) suggests that the cross-wind extent of these waves is large (200 - 700 km). From this we infer that over the 1-5 km length scales of our experiment, variations in 'external' conditions will be small and observed wind variations will be primarily due to local terrain effects.

Some indication of the impact of the mountains on boundary layer characteristics may be provided by results from the Boulder Atmospheric Observatory. This 300m tower is located in gently rolling terrain about 20 - 25 km east of Boulder, Colorado which itself lies right at the edge of the foothills of the Rocky Mountains (Kaimal, 1978). Analyses of mean wind profiles published to date by Sholtz and Panofsky (1980) and Korrell *et al.* (1982) for heights up to 150 km confirm existing formulae for homogeneous terrain and show no evidence of anomalous behaviour due to the mountains. Similarly Eversole's (1979) analysis of spectral characteristics of turbulence at the tower in April 1978 shows no pronounced mountain related features for heights up to 300m, although she does note the occurrence of occasional strong winds from the west. There is some evidence of increased low-frequency contributions to the horizontal velocity spectra for these conditions, but this

is attributed to the irregular terrain near the tower rather than to the mountains.

In summary, Kettles Hill appears to have been an excellent choice of site and we were fortunate in February 1981 in having almost perfect conditions for our experiment.

3. INSTRUMENTATION

3.1 Introduction

Two main wind measurement systems were employed in the experiment. The primary system consisted of ten 10m towers, 8 of which were in a fixed, east-west, linear array, as indicated in Figs. 5 and 6, while 10 portable 3m towers comprised the secondary system. The coordinate system used in Fig. 5 and throughout this report has its origin at the hilltop and the x-axis oriented due east (true). Data were recorded at each 10m tower on a SEADATA logger (12 bit A/D, 2 or 4 Hz digitizing frequency). The 3m tower data were taken manually. A sonic anemometer for high frequency turbulence measurement capability was mounted on the hilltop 10m tower with analog data being FM-recorded continuously inside an accompanying hilltop trailer. Also at the top of the hill was an AES standard model U2A anemometer mounted on a 10m tower. This produced wind speed and direction which were recorded manually at half-hourly intervals. An automatic mechanical weather station (MRI) measuring temperature, wind-speed and wind direction was placed 10m south of tower 5, approximately half-way down the upwind (west) slope of the hill (Fig. 5). On selected occasions, "AIRsondes", which measured dry bulb temperature, wet bulb temperature and pressure, were released from near the tower 1 location, just to the west of the hill. A microprocessor-based receiver station (AIR-ADAS) was used to process and print the data during each flight. Throughout the experimental periods, the air temperature was recorded at the top of the hill at half-hourly intervals. Arrangements were also made to collect U2A anemometer (10m speed and direction), temperature and humidity data from the Pincher Creek Airport meteorological observing station, approximately 12 km west of the hill, (Fig. 1), at half-hourly intervals.

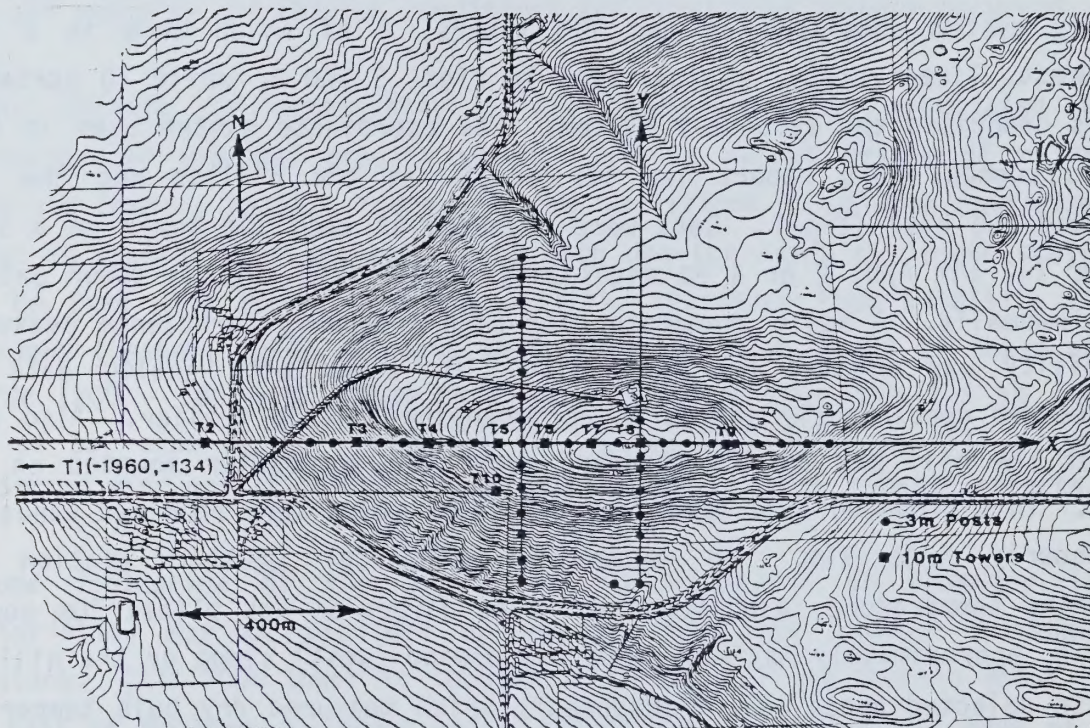


Fig. 5. Location of 3m posts and 10m towers.
Contour interval 1m. Dots indicate locations of portable 3m posts (N.B. not all locations were deployed at any one time) and squares show the locations of fixed 10m towers.

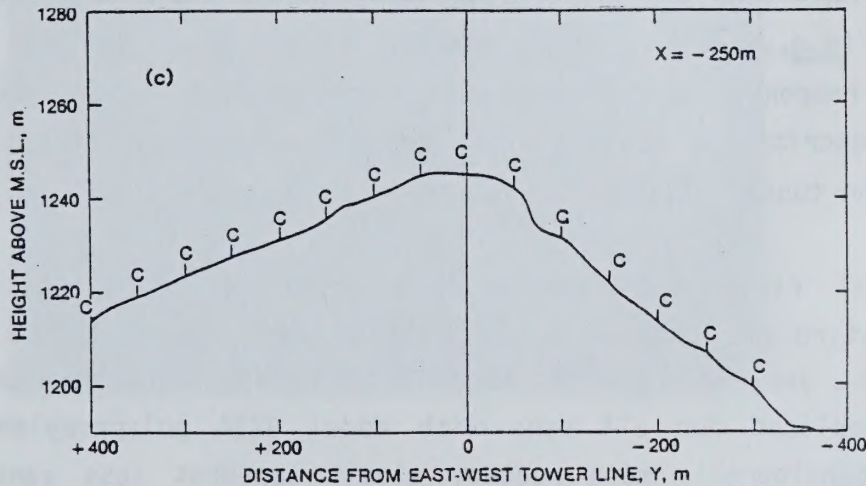
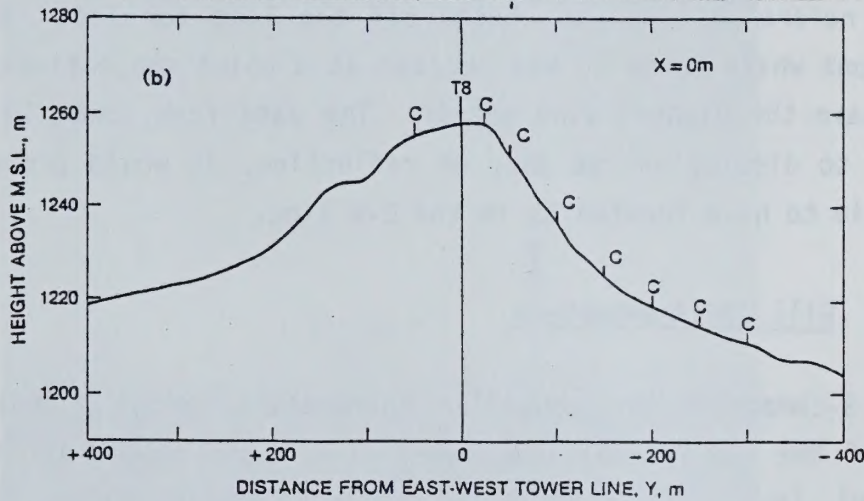
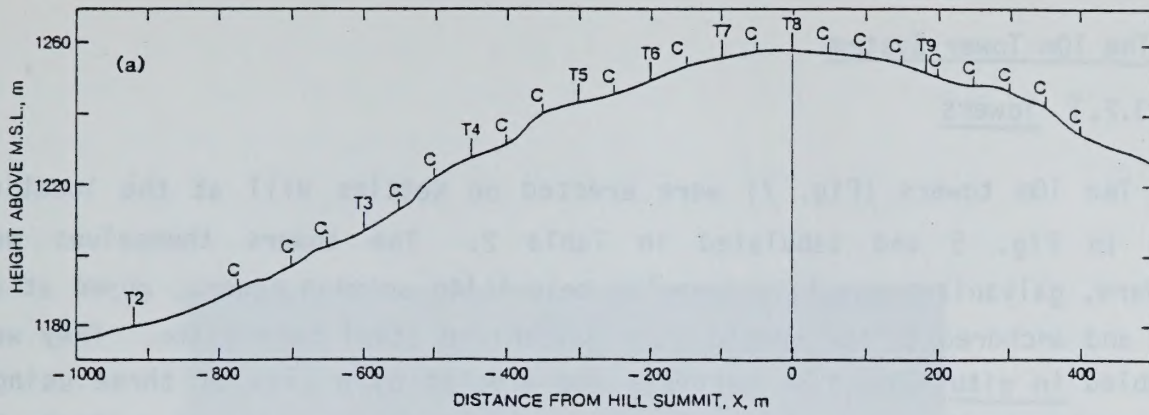


Fig. 6. Topographic cross-sections with post and tower locations shown.
 a) E-W cross-section at $y = 0$.
 b) N-S cross-section at $x = 0$
 c) N-S cross-section at $x = -250\text{m}$

"C" indicates a portable 3m post with Casella anemometer. "T" indicates a 10m tower.

3.2 The 10m Tower System

3.2.1 Towers

Ten 10m towers (Fig. 7) were erected on Kettles Hill at the locations shown in Fig. 5 and tabulated in Table 2. The towers themselves were standard, galvanized steel, triangular television antenna towers, guyed at one level and anchored to the ground on a galvanized steel base plate. They were assembled in situ from 3.3m sections and erected by a crew of three using a truck equipped with an electric winch. Most of the towers are in a single E-W line. The reference site was chosen off the line for local topographic and access reasons while tower 10 was located at a point subjectively estimated as likely to have the highest wind speeds. The data from tower 10 ends up being much harder to display or use and, on reflection, it would probably have been more sensible to have located it in the E-W line.

3.2.2 Gill UVW Anemometers

Gill 3-component UVW propeller anemometers (Model 27004) were mounted atop each of the 10m (climbable) towers at a total height of 11m above local ground level (e.g. Figs. 4, 7). The response characteristics of these anemometers have been discussed extensively in the literature and are now well understood (e.g., Hicks, 1972; Horst, 1973a, b). In the present case non-cosine response corrections were applied to all the data using the technique described by Horst (1973b) and the correction coefficients obtained from the wind tunnel calibration described in Appendix A.2.

Initial field measurements were attempted using Gill Model 21281 sensitive styrofoam propellers, but these were found to be incapable of surviving the very strong winds encountered during the experiment. They were therefore replaced for all runs with Model 8234 polypropylene propellers. These are considerably more rugged, albeit somewhat less sensitive. Their distance constant of 3.3m results in a typical upper frequency response limit (-3dB) of about 1 Hz at the mean wind speeds observed in the experiment (15 - 20 m s^{-1}).

Alignment and levelling of the Gill UVW anemometers was performed using a telescopic sighting device and bubble levels. Alignment was independently rechecked at the end of the experiment and resulted in the typical misalignment values listed in Table 2. No corrections were applied to the

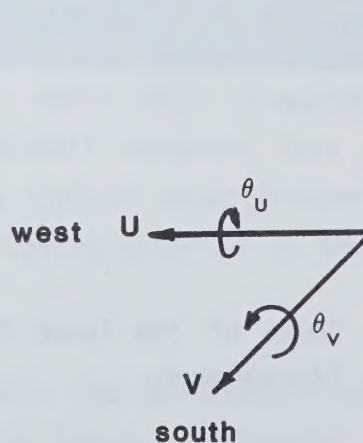


Fig. 7. Photo of 10m Tower System (background) and 3m Tower system (foreground).

Table 2 Gill UVW propeller anemometer body identifiers and Gill cup anemometer identification numbers associated with 10m towers. Also listed are the locations of the towers and their alignment and levelling errors.

10m Tower	X(m)	Y(m)	Gill UVW Propeller Anemometer Body	6m Gill Cup Anemometer Ident. No.	3m Gill Cup Anemometer Ident. No.	Tower Misalignment	
						$\theta(^{\circ})$ u	$\theta(^{\circ})$ v
1	-1956.0	-134.0	1	11	12	-	-
2	-921.3	0.0	2	9	10	+0.6	0
3	-604.0	0.0	3	5	6	+1.0	+0.2
4	-451.7	0.0	4	2	3	+0.8	+0.6
5	-301.6	0.0	5	17	14	+0.8	+0.8
6	-200.2	0.0	6	15	16	-0.9	-1.9
7	-99.2	0.0	7 ¹ , 11 ²	18	19	-0.1	0
8	0.0	0.0	8	20	23	-	-0.5
9	185.2	0.0	9	21	22		
10	-301.6	-97.6	10	7	8 ³ , 13 ⁴	+1.3	-0.6

- ¹ 12-17 February
² 18-23 February
³ 12-15 February
⁴ 16-23 February



results in view of the small size of these errors. Table 2 also relates the anemometer identification number to that of the 10m tower on which it was located during the experiment.

Analog signals from the tachometer - generators connected to the propellers were filtered at 1.5 Hz (-3dB) to remove electrical noise prior to digitization and recording on the SEADATA Loggers described in Section 3.8.

3.2.3 Gill Cup Anemometers at 6m and 3m

Gill cup anemometers were mounted on each tower at nominal heights of 6m and 3m above the ground. The actual heights of the cups were 6.4 and 3.0m respectively. They were located on horizontal booms which extended approximately 1 m out from the tower and were aligned to be upwind of the towers for the prevailing, westerly winds.

The Gill cup anemometer has a distance constant of 2.4m and threshold speed of 0.4m s^{-1} . All of the anemometers were calibrated before and after the experiment (see Appendix A). The anemometer responses were found to be linear. The cup assembly of the anemometer drives a d.c. tachometer generator whose analogue output voltage is directly proportional to wind speed. These analogue voltages were recorded by the SEADATA data-loggers at the 10m towers. The anemometer outputs were low-pass filtered at 1.5 Hz (-3dB).

For identification each anemometer was given a serial number. Table 2 relates the anemometer serial numbers to their respective locations.

3.3 The 3m Tower System

3.3.1 Towers

The portable 3m tower system included a total of ten towers, an example is shown in Fig. 7. Each was composed of a 3m length of 2" aluminum conduit topped by a Casella Sensitive Anemometer (Model 3106/TG). The tower was supported by three nylon guy ropes anchored to stakes driven into the ground. Attached to each tower at a convenient reading level was a self-contained counter display box for the Casella anemometer. Tower locations varied from run to run and are discussed in Section 4.

3.3.2 Casella Sensitive Anemometer

This unit is a three-cup anemometer which produces an electrical pulse for each revolution using a photocell-detector combination and a rotating opaque disk with a small radial transparent section. The Casella anemometer has a distance constant of 2.2m. It is estimated that it has a starting speed of less than $\sim 1 \text{ m s}^{-1}$. A report by Coppin (University of Hannover, to appear) indicates that the Gill and Casella cup anemometers have quite similar characteristics.

It should be noted here that the bearings of some of the Casella anemometers seemed to degrade noticeably during the course of the experiment, as evidenced by an internal grinding which grew louder as the days passed. This did not occur with all of the anemometers. Casellas B, C, E, I and J were "noisier" than the others. In their defense we should note that we were operating at about the limit of their recommended range of operation (15 m s^{-1}).

3.3.3 Casella Anemometer Counter Boxes

To keep track of the pulses generated by the Casella anemometer, an electronic counter and display box was designed and built by N. Koshyk of the Boundary Layer Research Division. To start a run, this device was reset to zero counts. The number of counts registered could then be displayed at any time on a "sample-and-hold" type of LED readout while the unit continued to count. The anemometer/counter combination was calibrated in the wind tunnel so that over any given interval of time, the amount of wind passing the anemometer and hence average wind speeds could be determined from the number of counts recorded.

The anemometer/counter combination was powered by a Gates rechargeable, sealed lead-acid 6-volt battery (model 0800-0011) with 5 Amp-hour capacity. It provided more than six hours of operation when fully charged.

3.4 U2A Anemometers

A U2A standard meteorological anemometer was mounted at a height of 10m on a separate tower near 10m tower number 8 (i.e., at the hilltop). During the experimental "runs" (see section 4.1) windspeed and direction (1 minute means) were taken manually from display units located in the instrument trailer. These readings were tabulated at half-hourly intervals.

The U2A data from the AES Pincher Creek Weather Station, located at Pincher Creek Airport, about 12 km to the WNW of the experimental site, were also compiled at half-hourly intervals by the staff at the station. Division of the hilltop results by the corresponding airport values produced simple, straightforward estimates of overall speed-up of the flow over the hill (see Section 4.3 and Appendix B.4)

3.5 MRI Mechanical Weather Station

This device (Model 1072), which logged wind run, wind direction and temperature on a mechanically driven strip chart, was placed approximately 5m south of 10m tower number 5. It operated continuously during the experimental period. The sensors were mounted on a tripod approximately 2.5m off the ground.

3.6 Sonic Anemometer-Thermometer

The sonic anemometer used was a Model DAT-300 Ultrasonic Anemometer-Thermometer, manufactured by Kaijo-Denki of Tokyo, Japan. It was mounted on the 10m tower at the hilltop (tower 8) at the same height as the Gill UVW anemometer, but displaced about 1m in the cross-wind direction (Fig. 4). Its purpose was to obtain turbulence information for all three wind components to frequencies considerably higher than those which could be reached by the Gill anemometers, and hence to act as a calibration or reference instrument against which the Gill results could be compared.

The sonic anemometer operates on the principle of measuring the difference in time required for sound pulses travelling in opposite directions to traverse the identical path (whose length is 20 cm for the Kaijo-Denki

Model DAT-300). By subtracting the two travel times and making some fairly reasonable assumptions, the speed of motion (in the direction of the path) of the parcel of air through which the sound pulse travelled is obtained. Similarly, by adding the two travel times and making further assumptions, instantaneous air temperature can be obtained, albeit somewhat less reliably than velocities in non-neutral stability conditions. The fundamental operating principles of sonic anemometers can be found in the Kaijo-Denki instruction manual and in Kaimal (1980). The latter gives an excellent description of their accuracy and limitations. For our purposes, the sonic anemometer can be assumed to produce accurate velocity measurements for all three components to about 10 Hz. It can also be considered a reliable estimator of neutrally-stable atmospheric conditions in the near-surface flow insofar as its measured vertical heat flux (wT) is zero or near-zero.

3.7 AIRsonde System

AIRsondes (Atmospheric Instrumentation Research, Inc., Boulder, Colorado) were flown during the latter part of the experiment. These helicoid propeller-shaped packages were flown on free balloons and tracked to heights of 5 km. Precision sensors provided wet (T_w) and dry (T_a) bulb temperatures (accuracy 0.2°C, thermistor match 0.1°C, resolution .05°C; time constant $T_a \sim 3s$, $T_w \sim 12s$) and pressure (accuracy 3 mb, resolution 0.1 mb) data which were transmitted to a ground station (403.5 M Hz). Microprocessor circuitry in the ground station provided real time profiles in engineering units for recording on digital cassettes and printer output.

3.8 Data Logging

3.8.1 10m Towers

Except for towers 5 and 10, which used a common logger because of their proximity, the data from the propeller and cup anemometers on each tower of the primary system were recorded on a portable, dedicated electronic logging device, the SEADATA Model 1250 Data Logger. This device has a 12 bit A/D converter and records from four to twelve analog inputs at scan rates up to 4 Hz. In the recording process, the analog inputs (filtered voltages from the anemometers) are digitized and then written on a Phillips type cassette tape along with header and interval information (on each scan of the input channels). Once recording of the data is completed, the cassette can be

"played back" through a SEADATA Model 12A Cassette Reader to produce a computer compatible tape. A single cassette can hold up to 6.5×10^5 samples. The logger can operate on an internal battery for periods of sufficient length for our purposes.

The procedure for logging the data began each day with a simultaneous "clock reset" of all of the loggers. They were then taken to their respective towers and connected to the filtered outputs of the various anemometers. At the end of the day, the loggers were collected, the cassettes removed and a selection of the cassettes verified for proper operation of the loggers.

3.8.2 3m Towers

Collection of data from the 3m tower system was done manually by two people. Each person typically collected data from five of the towers as follows. At the start of an experimental "run", the operator would walk down the line of the towers and, at intervals of 1 min (usually), reset the counters to zero. After resetting at the last tower he would return to the beginning of the line. Following a set interval (usually 15 min from the reset time of his first tower) he would write down the number of counts for this tower. He would then move down the line of towers taking readings for the same set interval at each tower. Data were collected in this manner for typically 2 to 3 hours. The data from the 3m tower system therefore represent 15 min averages which are staggered by intervals of up to 4 or 5 min, depending on the tower configuration and the division of labour.

3.8.3 Sonic Anemometer-Thermometer

Sonic anemometer data were recorded in the field using a four-channel FM Analog tape recorder (Hewlett-Packard, Model 3964). The analog tapes containing the four continuously recorded signals (u, v, w and T) were then returned to the laboratory and replayed into a digitization and analysis system following the experiment. This system is based on a PDP-15 digital computer (see Teunissen, 1977). Digitization was carried out at 30 Hz after analog filtering of the signals at 15 Hz. The digitized signals were permanently stored on digital magnetic tape for subsequent statistical analysis and archiving.

4. DATA SYNOPSIS

4.1 Experimental Runs

A "run" is defined for the experiment as a period of time during which data from most of the towers were being logged - i.e., the 10m tower system, the 3m tower system, the U2A anemometers and the sonic anemometer. The MRI system functioned continuously. In general, attempts were made to have a morning and afternoon run each day, although this did not always occur. For all runs, the 10m towers were located as shown in Fig. 5 and listed in Table 2. The 3m towers, however, occupied various positions on the hill, depending on the run numbers. In each case, the towers were set up in a linear array as indicated in Figs. 5 and 6 and tabulated in Table 3.

Table 4 is a synopsis of the runs performed during the course of the experiment. It includes wind speed and direction averages from the U2A anemometers at the airport and the top of Kettles Hill as well as those from the reference tower (10m tower 1) upwind of the hill. The weather conditions are described along with the type of ground covering on Kettles Hill. When used in conjunction with Figs. 5 and 6 and Tables 2 and 3, Table 4 provides a complete summary of times, locations and ambient conditions for the experimental runs. Table 4 also includes the time periods for which sonic anemometer data were collected, for completeness. Detailed results from this system will be presented in a subsequent report dealing with the turbulence measurements obtained during the experiment. It should be pointed out here that for some runs (eg. 5a, 5b) the 10m tower data loggers logged continuously throughout the day while the 3m tower system was polled for two separate periods (usually morning and afternoon). Thus, a more extensive period was logged by the 10m tower system than is indicated by the 3m tower information. For most of the runs the wind speed and direction did not change significantly within the observing period (typically 1-1/2 to 2 hrs) and the data can be considered as representing 'steady state' conditions.

As we have indicated in Section 2, all runs were conducted with moderate to strong, west to south west winds at the surface. The 500mb charts (CMC analyses) for the period show a widespread westerly flow developing over western Canada and the eastern Pacific on 12 Feb. and persisting throughout the observation period (12-22 Feb. 1981). Prior to this time the upper air flow in the area had been from the NNW while a generally disturbed pattern

Table 3 Locations of 3m towers during experimental runs. The X and Y coordinates (in metres) refer to the local coordinate system shown in Figure 5.

Run 0a, 1a, 2a			Run 3a, 3b			Run 5a,5b		
Tower	X(m)	Y(m)	Tower	X(m)	Y(m)	Tower	X(m)	Y(m)
A ²	0	0	A	0	0	A	-775	0
B	50	0	B			B	-700	0
C ²	100	0	C	100	0	C	-650	0
D ²	150	0	D			D	-600	0
E ²	200	0	E	200	0	E	-550	0
F ²	250	0	F	250	0	F	-500	0
G	300	0	G	300	0	G	-400	0
H ¹	350	0	H	150	0	H	-350	0
I ¹	-50	0	I	-50	0	I	-250	0
J	400	0	J	50	0	J	-150	0

¹ Runs 1a, 2a only

² Runs 0a, 1a only

Run 6a, 7a, 7b			Run 8a			Run 9a,9b		
Tower	X(m)	Y(m)	Tower	X(m)	Y(m)	Tower	X(m)	Y(m)
A	0	50	A	-250	150	A	-250	150
B	0	0	B	-250	100	B	-250	100
C	0	- 25	C	-250	50	C	-250	50
D	0	- 50	D	-250	0	D	-250	0
E ³	-50	-300	E	-250	- 50	E ⁴	-250	-50
F	0	-150	F	-250	-150	F	-250	200
G	0	-200	G	-250	-200	G	-250	250
H	0	-250	H	-250	-250	H	-250	300
I	0	-300	I	-250	-300	I ⁵	-250	350
J	0	-100	J	-250	-100	J	-250	400

³ Runs 7a, 7b only

⁴ Moved to (-250, 350) for run 9b

⁵ Run 9a only

Table 4 Summary of Experimental Runs and Ambient Conditions.
 All times are local (MST); wind speeds in m s^{-1} ;
 wind directions in degrees; AI = averaging interval (min);
 SI = sampling interval (s).

DATE Feb. 1981	RUN	3m Towers		AIRPORT WIND		REFERENCE WIND (10m Tower 1)		HILLTOP WIND (10m Tower 8)		10m Towers		SONIC ANEMOMETER MEASURE- MENT PERIOD	WEATHER CONDI- TIONS	GROUND COVER
		DURATION	AI	SPEED	DIRECTION	SPEED	DIRECTION	SPEED	DIRECTION	DURATION	ST			
	0a	12	1540-1655	15	N/A	-	-	N/A	N/A	1515-1730		-		snow covered
	1a	14	1300-1500	10	20 13-24	250 250-250	-	22 16-27	247 238-258	1300-1830		1306-1456	6-7°C	60% snow
	2a	15	1545-1715	15	14 10-18	253 250-260	12.1 11.2-14.0	251 249-254	19 18-20	247 245-250		1401-1550	4-8°C	10% snow, mostly on downwind slope and in gullies
	3a	16	1140-1210	10	9 7-11	240 240-240	-	5 3-8	345 320-010	1130-1630		-	6-11°C Calm for 1/2 h around 1200	Very little snow, mostly on downwind slope and in gullies
	3b	16	1340-1510	10	10 9-11	250 240-260	9.2 8.4-10.9	259 254-265	13 11-14	254 240-260		1407-1608		
	4	17	Not done	Not done	-	-	-	13 12-15		1200-1630	.25	1257-1447	5-7°C	virtually no snow; mostly on downwind slope and in gullies
	5a	18	1300-1400	15	10 8-11	243 240-250	10.6 10.2-10.9	257 249-262	14.6 13.6-15.2	259 252-262		1233-1423	4-7°C Sunny. Clear skies after snow squall at 1200; some alto cirrus	no snow; grass (~3cm deep) and mud
	5b	18	1510-1640	15	9 9-10	250 240-260	12.8 12.1-13.9	255 253-257	15.1 14.5-15.7	256 254-258		1447-1636		
	6a	19	1520-1650	15	8 8-8	220 210-230	8.3 7.3-9.9	220 210-232	13.0 11.9-14.8	220 213-232		1208-1357	4-6°C; heavy rain 1300-1330; then clear	Grass stubble
	7a	20	1030-1200	15	12 10-13	245 240-250	12.2 11.7-13.0	262 260-264	15.1 14.6-15.8	264 262-266		1031-1220	3-5°C Sunny.	Grass stubble
	7b	20	1330-1500	15	14 12-15	248 230-260	13.6 13.2-13.9	260 257-261	17.0 16.7-17.4	262 258-265		1246-1435		
	8a	21	1400-1600	15	11 9-12	246 240-250	12.0 10.9-13.0	263 259-269	15.8 13.9-16.9	268 262-273		1324-1513	4-6°C; sunny with some clouds over mountains	Grass stubble
	9a	22	1100-1230	15	11 9-14	233 230-240	10.3 8.6-11.7	251 245-258	13.8 11.9-16.4	252 247-256		1140-1329	4-10°C; 50% cloud cover until 1130, then mainly sunny. Lentic- ular clouds to S, aligned NW-SE.	Grass stubble
	9b	22	1330-1530	15	12 11-14	254 250-260	13.3 11.4-14.2	261 259-263	17.3 16.4-18.6	262 259-264		1356-1546		
	10*	23	1000-1530	-	-	-	-	3-11	270-060	-	.5	-	4-8°C; light snow after 1200 when wind shifted to 070°	Grass stubble

* mean and range of AI averages
 * from U2A (10m) on top of Kettles Hill - average for duration of run
 * from U2A (10m) at Pincher Creek Airport - average for duration of run
 * profile run - Towers 1 and 8 only - Tower 8 in wake of trailer after 1200

evolved between Feb. 21st and Feb. 23rd. Surface analyses from the Alberta Weather Centre of AES for the period showed a persistent ridge of high pressure extending from the U.S. into the mountains of south eastern British Columbia with a typical lee trough over southern Alberta and southern Saskatchewan. Minor disturbances passed through the area but did not seriously disturb the basic Chinook pattern until the end of our observing period.

The nearest upper air station is at Great Falls, Montana, about 300 km SE of Pincher Creek. The station is in a somewhat similar location relative to the mountains as Pincher Creek and the ascents could reasonably be expected to show similar conditions to those prevailing at our site. However Portelli (1977) does show local variations in mixing height climatology which would suggest that average winter and spring mixing heights might be 100-200m lower at Pincher Creek than at Great Falls. Portelli's mixing heights - based on the 1200 GMT sounding and the afternoon maximum surface temperature - show a February average for Great Falls of about 800m rising to 1300m by March. The USAF Base at Malmstrom kindly supplied copies of their rawinsonde data (twice daily Skew T-log p diagrams) for the period of our experiment. These often showed quite strong surface based inversions (about 2°) but above that usually indicated a fairly well-mixed layer up to heights between 1500 and 2000m above the local terrain. As sometimes happens with mechanically mixed layers they were often slightly stable ($2-3^{\circ}/\text{km}$) in terms of potential temperature but they were capped by shallow layers with very strong stable potential temperature gradients (typically about 4° in 200m).

Our own programme of AIRsonde releases at the site was unfortunately not started until 21st Feb. 1981. The flights that were made (on 21st and 22nd Feb.) typically showed very well mixed layers with neutral stratification up to heights of about 800m (see Fig. 8) with a shallow inversion ($1-2^{\circ}$) at that level and stable to neutral stratification above. On two occasions (21 Feb., 10:36 and 22 Feb., 10:24) additional strongly stable layers were found at heights of about 2km. It is these layers which are more likely to correspond to those observed at Great Falls. Coupled with the high winds observed at the site the data we have indicate that we can safely assume near neutral stratification to heights of about 1 km at Kettles Hill during our observation period. It would clearly have been desirable to operate our AIRsonde system throughout the full experiment.

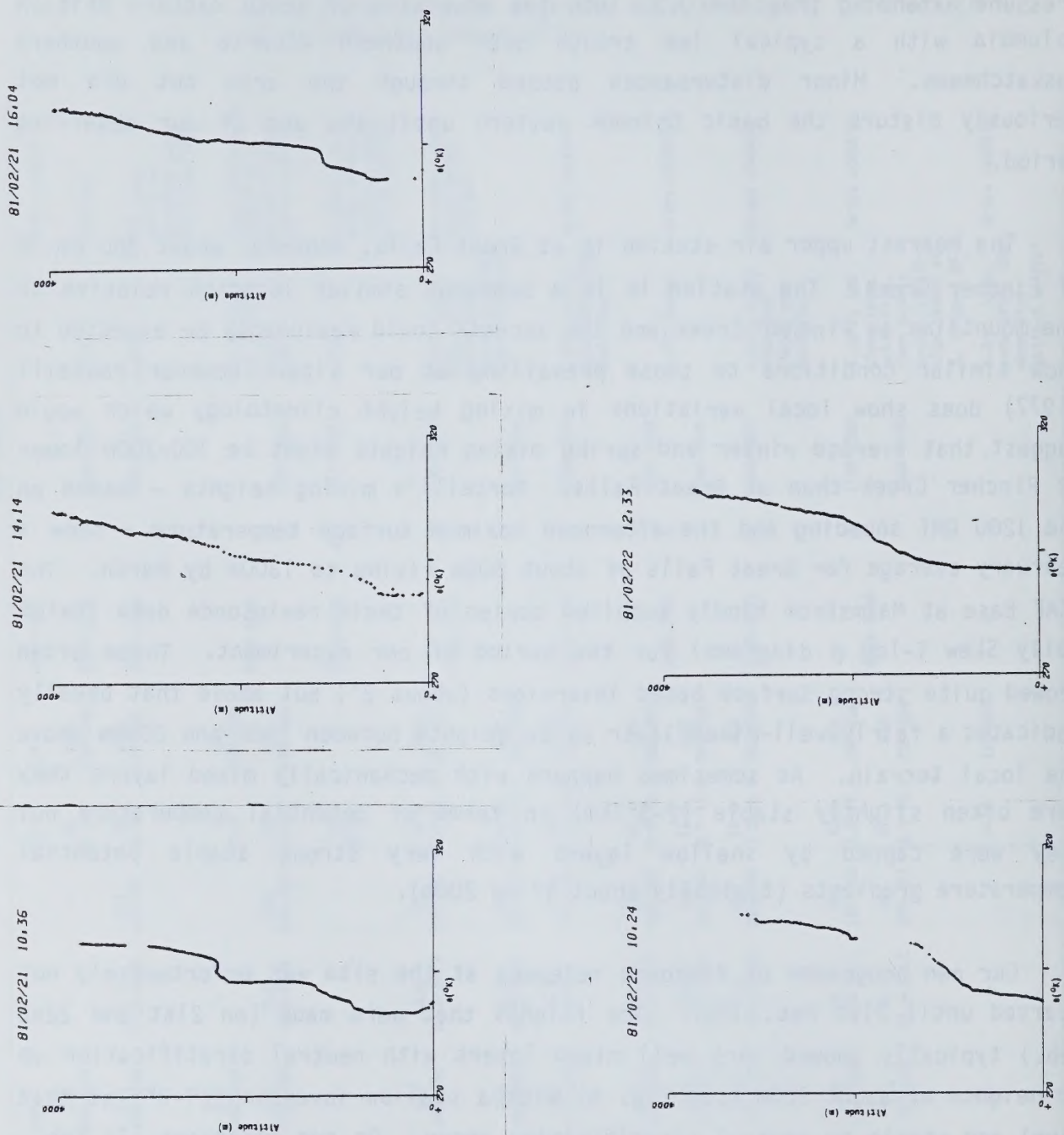


Fig. 8 AIRsonde potential temperature profiles for Feb. 21 and 22, 1981. Launch was from tower 1 location.

A detailed compilation of the data collected during the experiment is presented in Appendix B. It includes wind speed and direction averages from the 10m tower system, wind speed averages from the 3m tower system, instantaneous surface temperature data and summarized data from the continuously logged MRI mechanical weather station.

A graphical summary of the wind speed data appears in Figs. 9 to 16. In these figures, wind speed-up is plotted against the location of the particular tower in the linear array. The origin (0,0) is at the top of the hill. Speed-up calculations have been done for the 10m, 6m and 3m (Gill and Casella) heights. In this case, speed-up is defined as the ratio of the measured wind speed to a "reference" wind speed. The reference wind speeds were taken from the appropriate anemometer on 10m tower no. 1. Tower no. 1 may not always be truly representative of the undisturbed flow but no account of this is taken here. The data for these plots were taken from the tables of Appendix B and have been averaged (average of several 10 or 15 min averages) over the entire run. The vertical bars represent the span between the largest and smallest speed-up (using the 10 or 15 min averaged data) encountered during the run. Note that the triangular symbols represent data from the 10m tower system while the circular symbols apply to the 3m tower (Casella) data. For some runs the 3m portable tower array was collinear with the 10m tower array and the 3m speed-up data (Casella and Gill) all appear on a single graph. For the other runs separate graphs are necessary to represent Casella and Gill data.

In Fig. 17 a sample of the distribution of measured wind directions at 10m for run 5a is shown. The data are taken from Table B.1a. The deviation of the 15 min averaged wind direction from the 15 min averaged reference wind direction is plotted at each tower location. The values graphed are the total averages taken over the complete run while the vertical bars represent the span of 15 min averaged wind direction deviations. Wind direction perturbations are seen to be small and are a less pronounced feature than speed-up for this hill.

Several brief comments can be made concerning the speed-up data. In the first place the general level of consistency between towers and especially

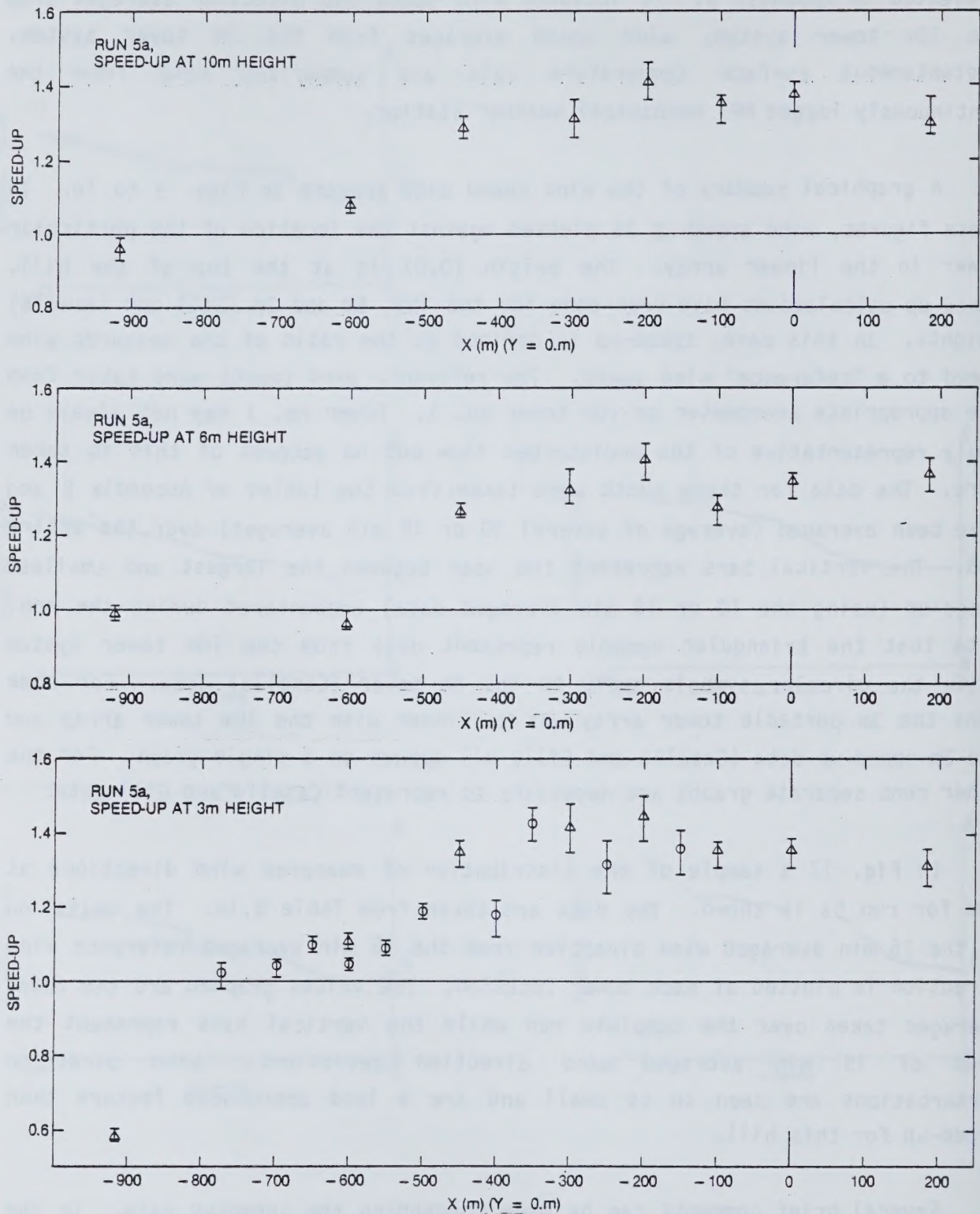


Fig. 9. Speed-up Data for Run 5a. The range of averaged reference wind directions for the run was 249°-262°.

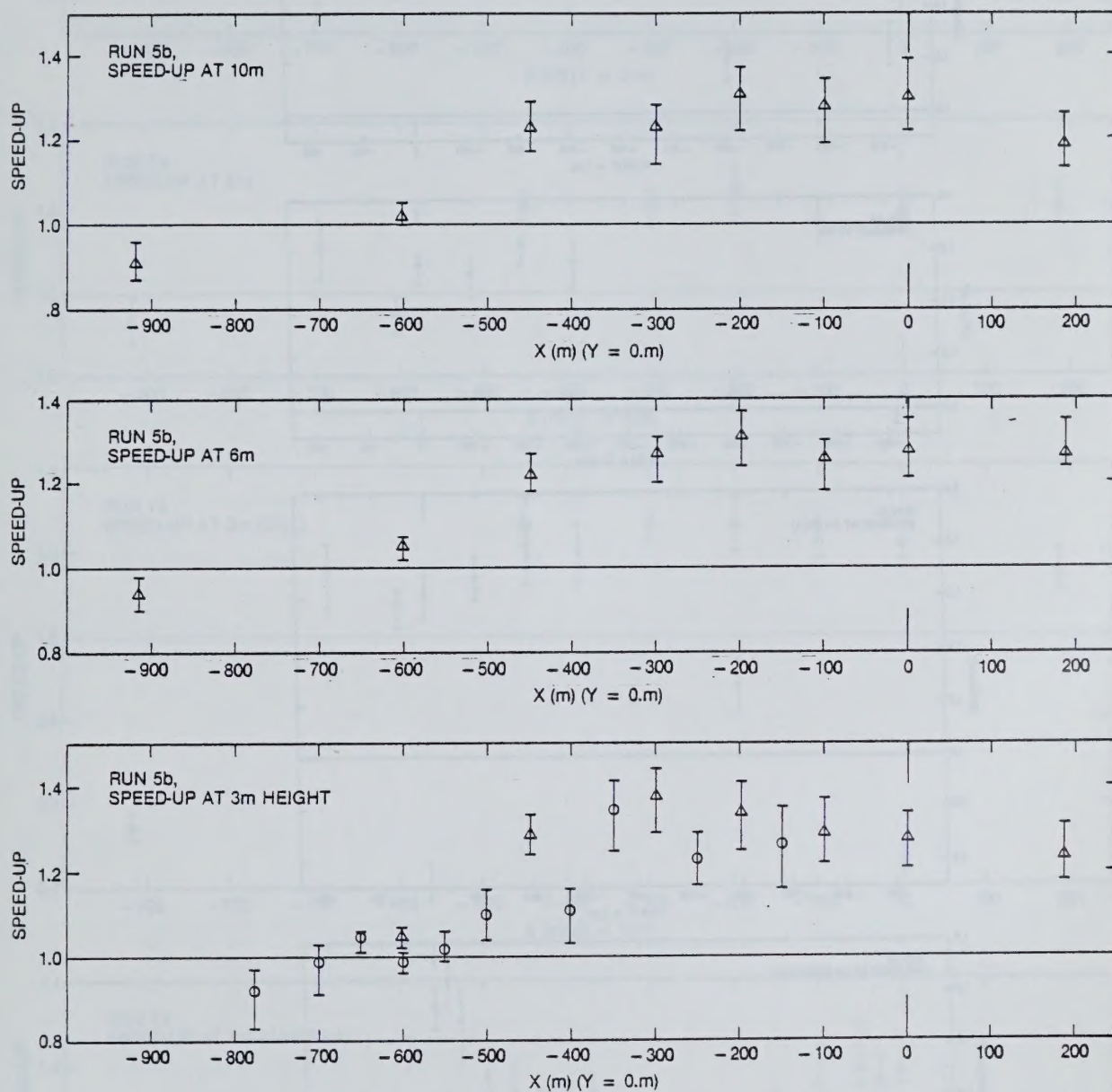


Fig. 10. Speed-up Data for Run 5b. The range of averaged reference wind directions was 253°-257°.

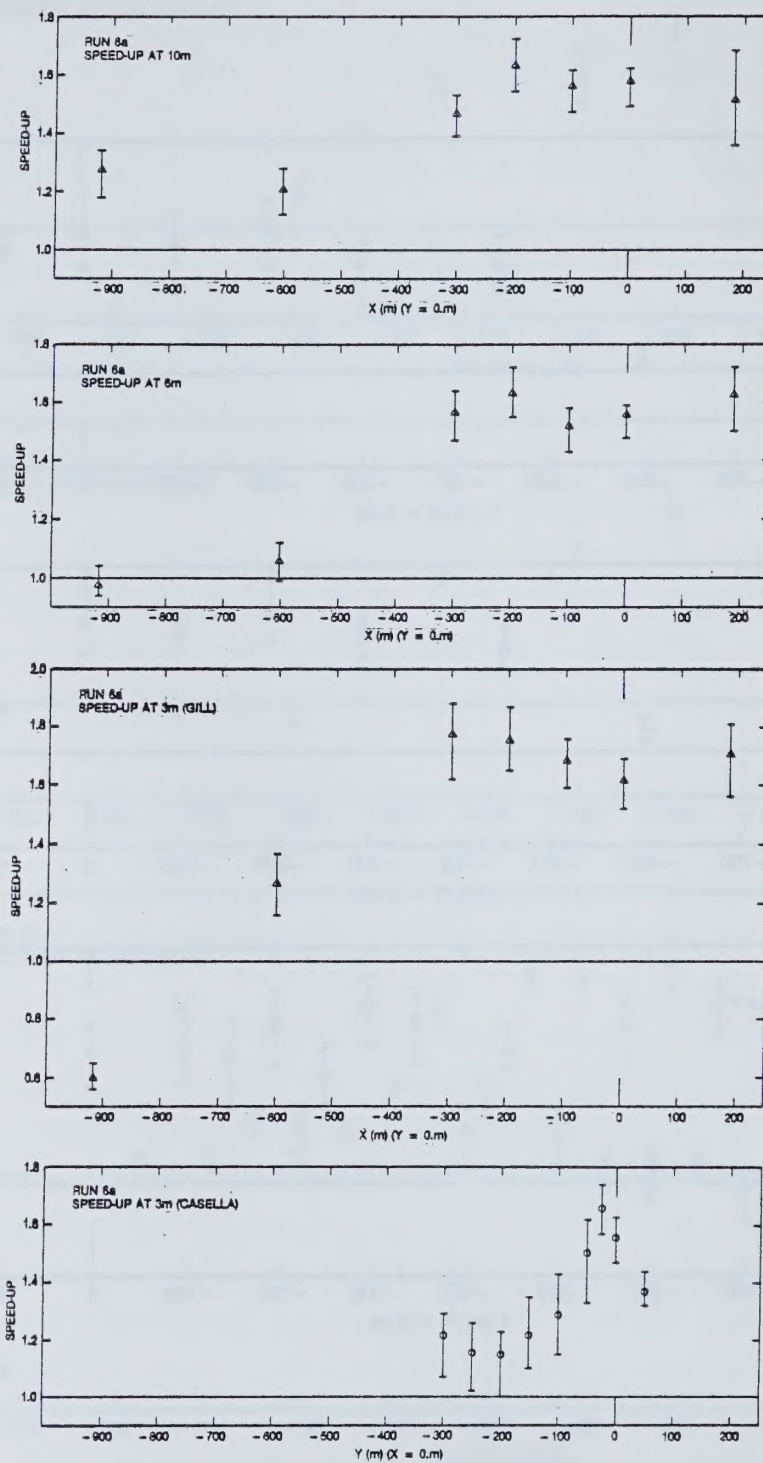


Fig. 11. Speed-up Data for Run 6a. The range of averaged reference wind directions was 210° - 232° .

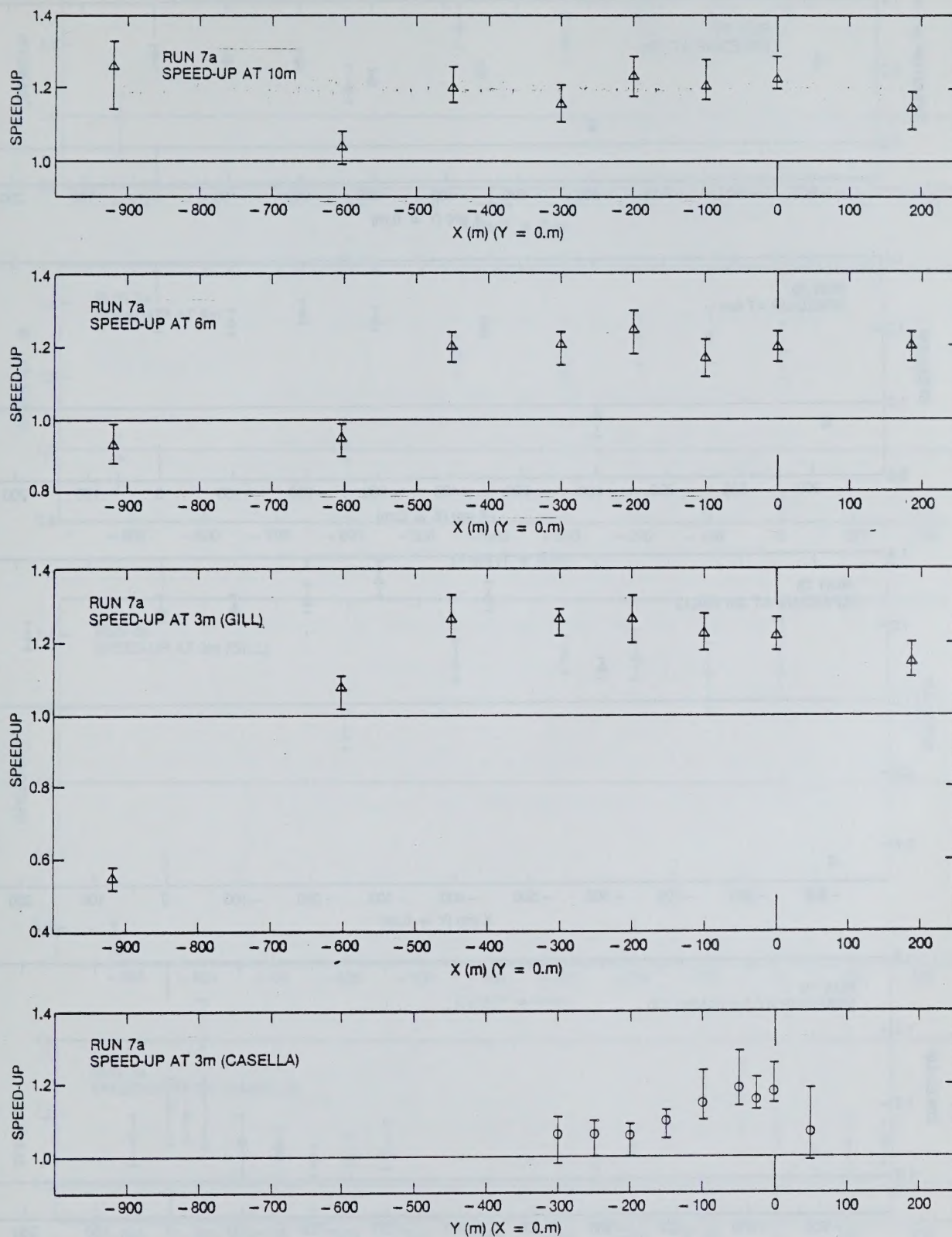


Fig. 12. Speed-up Data for Run 7a. The range of averaged reference wind directions was 260°-264°.

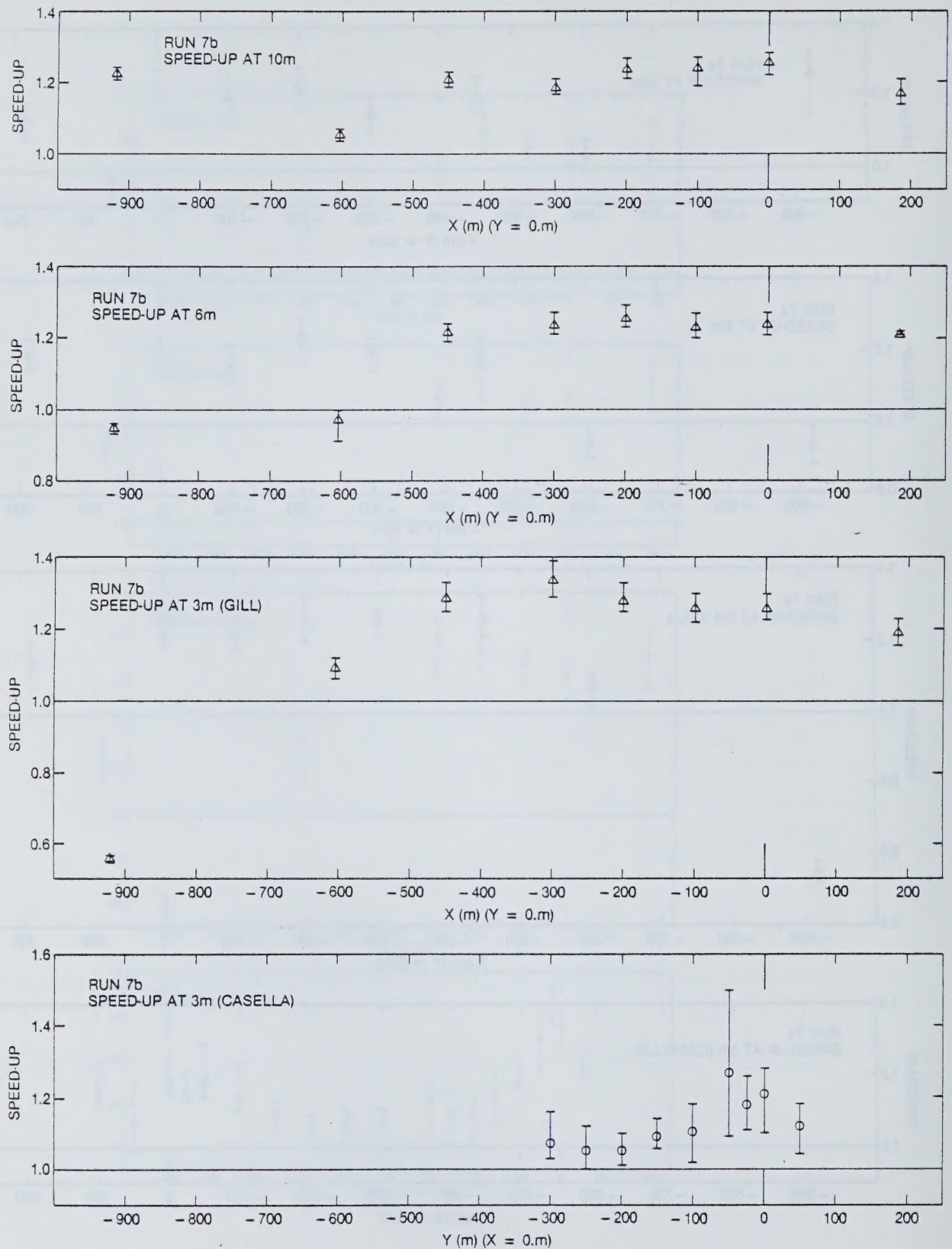


Fig. 13. Speed-up Data for Run 7b. The range of averaged reference wind directions was 257°-261°.

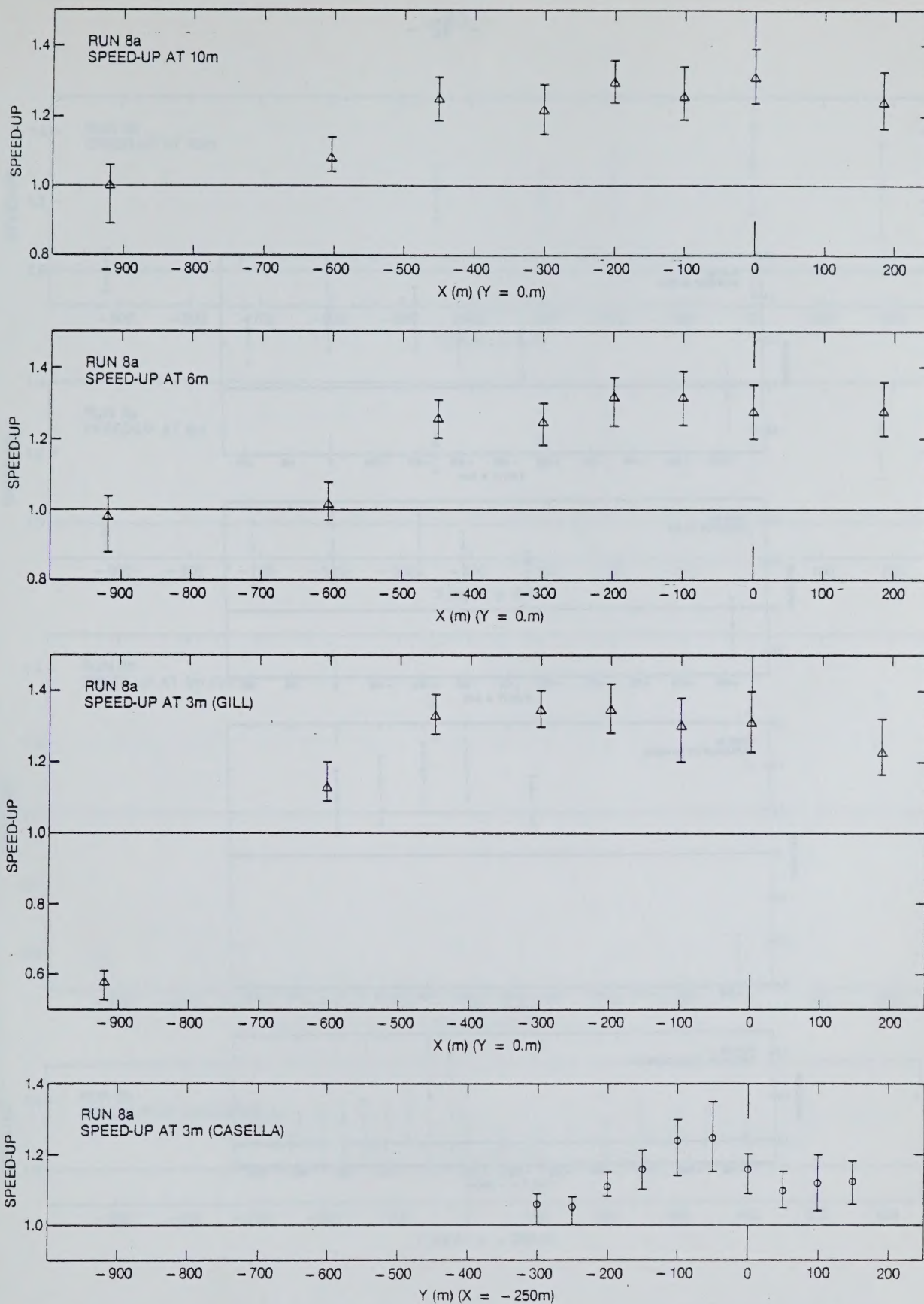


Fig. 14. Speed-up Data for Run 8a. The range of averaged reference wind directions was 259°-269°.

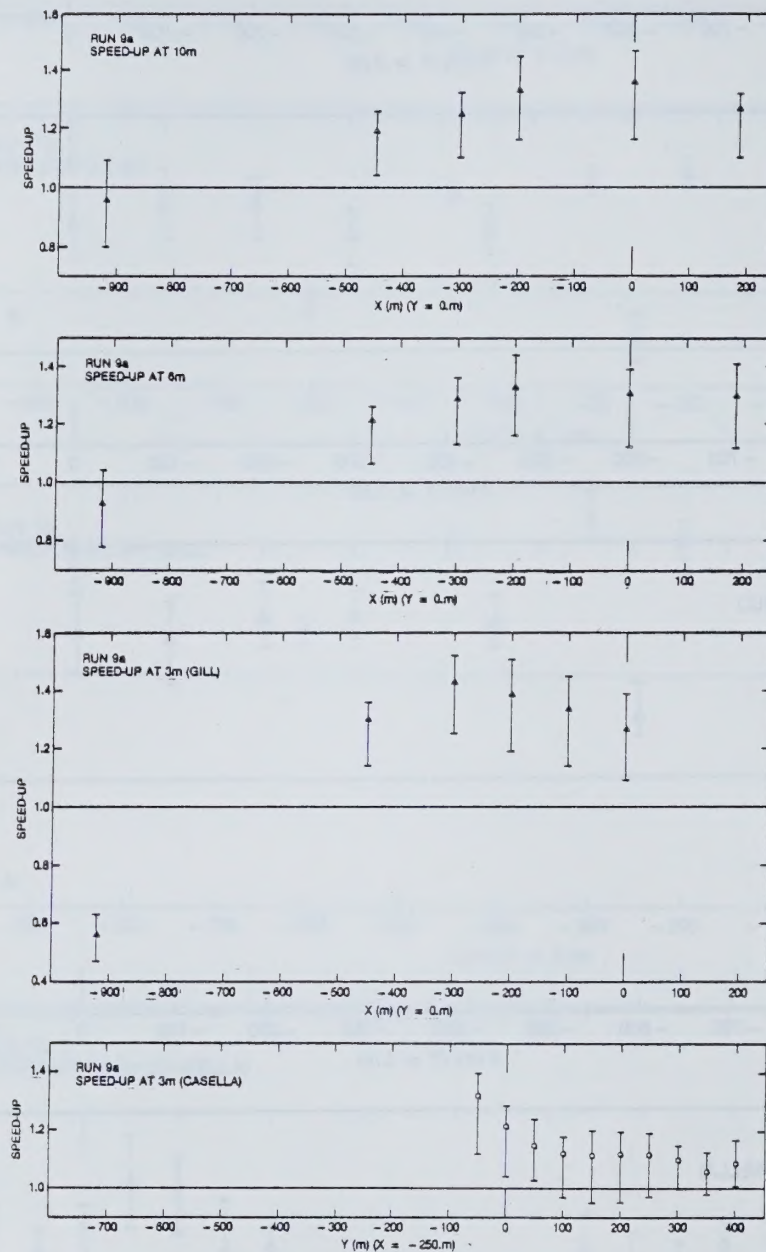


Fig. 15. Speed-up Data for Run 9a. The range of averaged reference wind directions was 245° - 258° .

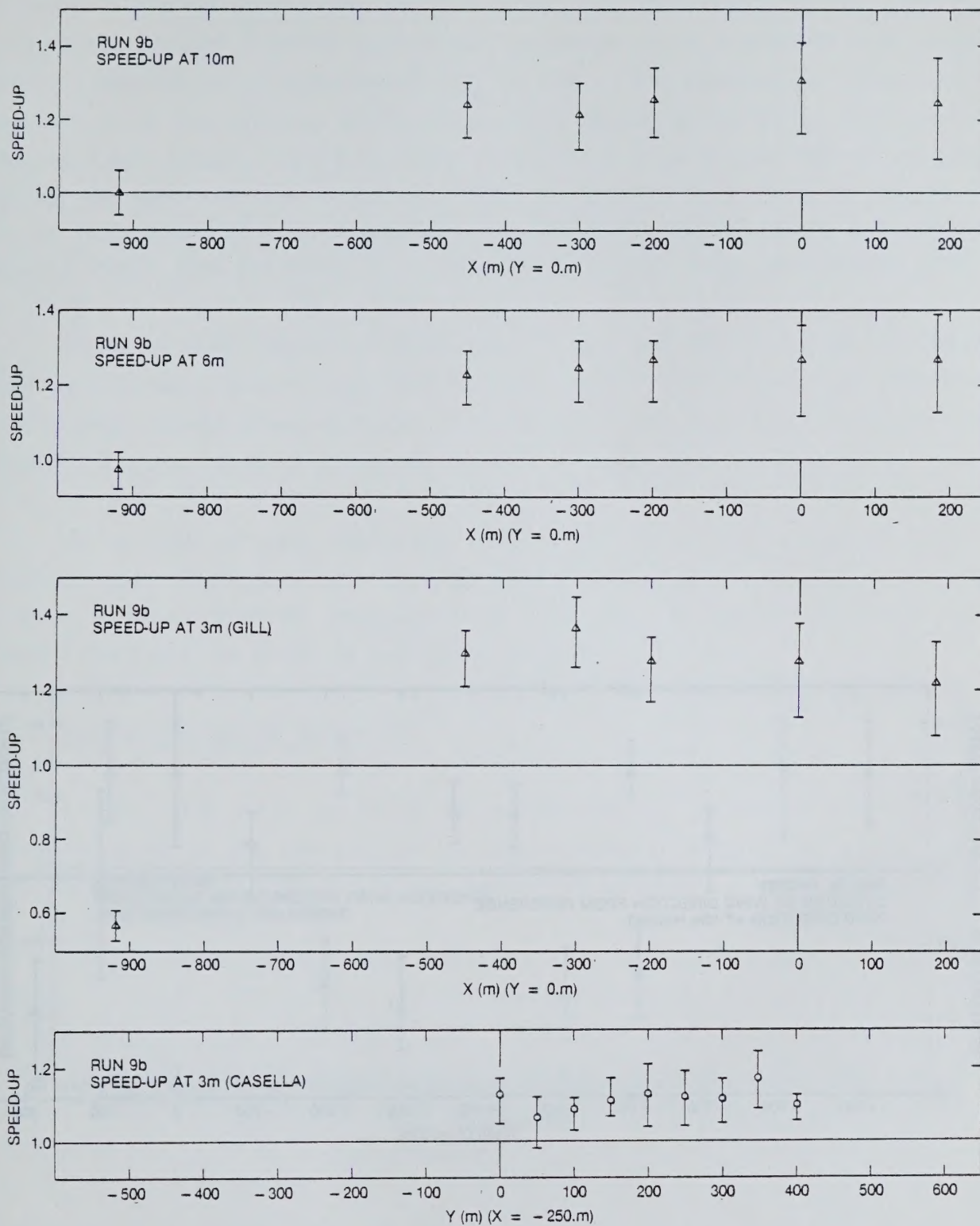


Fig. 16. Speed-up Data for Run 9b. The range of averaged reference wind directions was 259° - 263° .

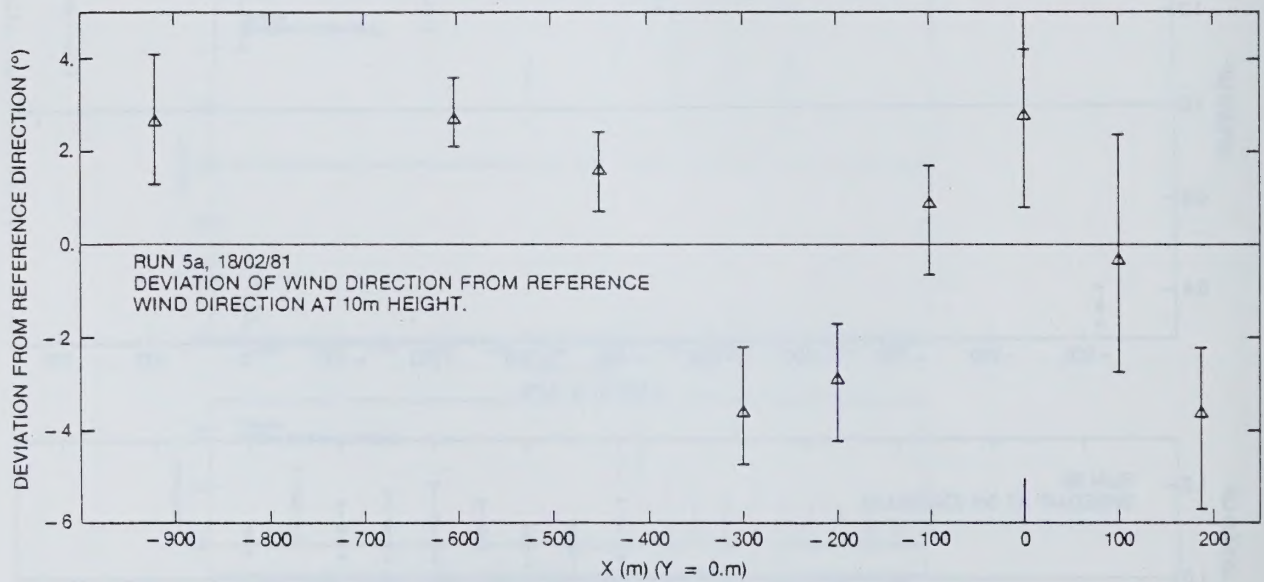


Fig. 17. Wind Direction Data for Run 5a. The average reference wind direction was 256.5°.

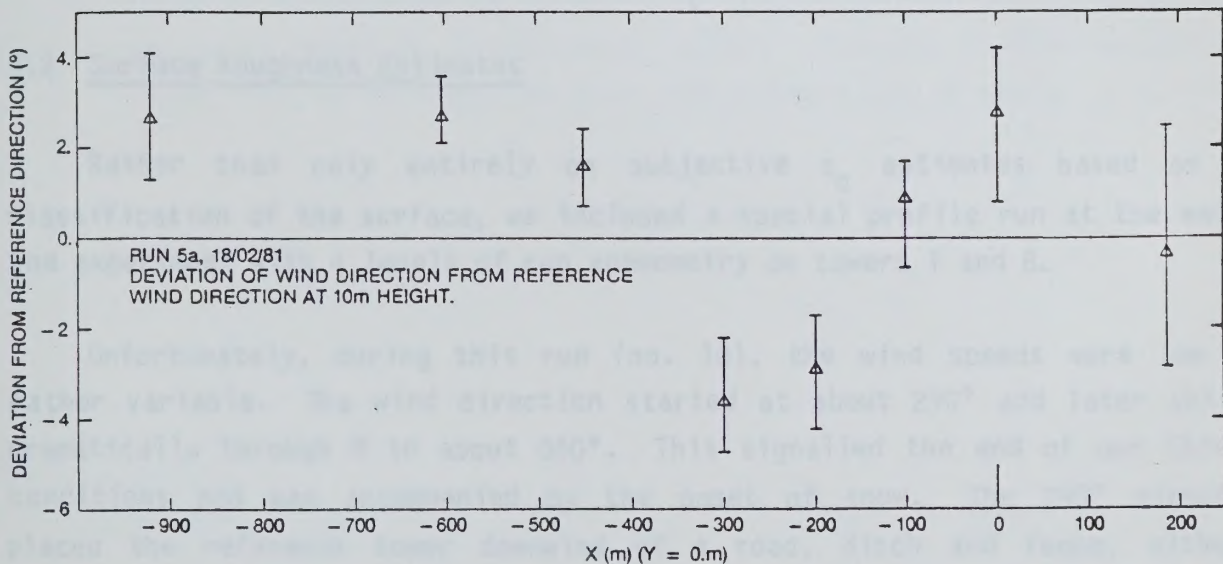


Fig. 17. Wind Direction Data for Run 5a. The average reference wind direction was 256.5°.

between different levels on the 10m towers is most encouraging. The only exception is tower 2 where there clearly appears to be a problem with anomalously low winds being measured at the 3m level. The observations show spatial variations in the speed-up on the hill which appear to be fairly well resolved by our tower arrays. There is clear evidence of a strong dependence of speed-up on the upstream wind direction. This is especially evident in run 6a for which the reference wind direction is about 220° and speed-ups are substantially higher than for other runs, most of which have directions nearer 250° .

There is some indication from runs 5a, 5b, 6a, 7a, 7b, where 3m Casella and 3m Gill data is available for the same points, that there is a consistent difference between them, with the Gill speeds being about 4-6% higher than the Casella values. This is discussed further in Appendix A, Section 5.

As we have already indicated a specific aim of the experiment was to collect mean wind speed data for comparison with theoretical and wind tunnel models. More detailed discussion of the data in comparison with model predictions will be given in subsequent reports.

4.2 Surface Roughness Estimates

Rather than rely entirely on subjective z_0 estimates based on the classification of the surface, we included a special profile run at the end of the experiment with 4 levels of cup anemometry on towers 1 and 8.

Unfortunately, during this run (no. 10), the wind speeds were low and rather variable. The wind direction started at about 290° and later shifted dramatically through N to about 060° . This signalled the end of our Chinook conditions and was accompanied by the onset of snow. The 290° direction placed the reference tower downwind of a road, ditch and fence, although estimates of z_0 based on the profiles, which are shown in Fig. 18, are still in the range 1 - 10 cm. Data from the 1.55m level on tower 1 have not been used as the anemometer (previously at the 3m level on tower 2) was subsequently found to be giving low readings throughout the experiment. The logarithmic profiles for tower 8 are not as clearly defined as one might wish. The consistent shape of the profile in all the 10 min. blocks

illustrated suggests possible errors in anemometer calibrations. The shape could be due to terrain effects, but, locally, the hilltop itself was relatively flat and would not be expected to produce such effects. Our estimate of z_0 from these profiles at the hilltop is 1 cm. Because of the uncertainties in data from the profile run we have also used the 3m and 6m cup anemometer wind speeds at these two towers to estimate z_0 values from other data runs. (The 10m speeds were not used because of possible differences in absolute calibration.) The z_0 and local u_* values are computed based on the assumption that:

$$u_6 = \frac{u_*}{\kappa} (\ln 6.44 - \ln z_0)$$

$$u_3 = \frac{u_*}{\kappa} (\ln 3.02 - \ln z_0)$$

with $\kappa = 0.4$. Values are given in Table 5. In general they, and the hilltop profiles, are consistent with our prior estimate of 1 cm for z_0 and this value will be assumed. Similar computations at other towers gave widely varying z_0 values as one might expect from non-equilibrium profiles.

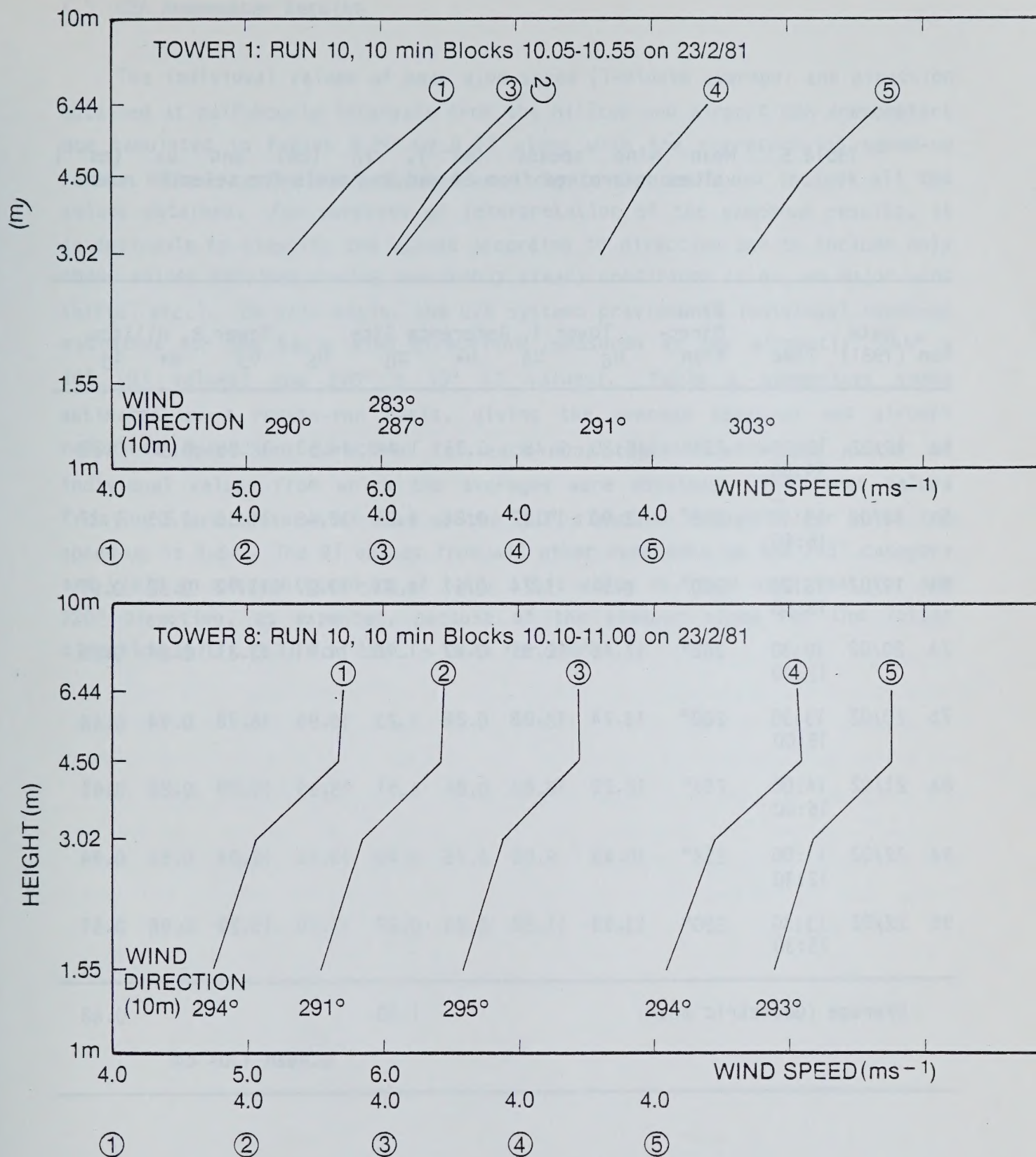


Fig. 18. Wind Profiles for Run 10.

Table 5 Mean wind speeds (ms^{-1}), z_0 (cm) and u_* (ms^{-1}) values determined from 6m and 3m levels for selected runs.

Run	Date (1981)	Time	Wind Direc- tion	Tower 1, Reference Site				Tower 8, Hilltop			
				U ₆	U ₃	u*	z ₀	U ₆	U ₃	u*	z ₀
5a	18/02	13:00- 14:00	255°	10.80	9.46	0.71	1.44	14.53	12.88	0.87	0.82
5b	18/02	15:10 16:40	255°	12.93	11.37	0.82	1.21	16.48	14.50	1.05	1.17
6a	19/02	15:20 16:50	220°	8.51	7.24	0.67	4.03	13.27	11.72	0.82	0.97
7a	20/02	10:30 12:00	262°	12.46	10.91	0.82	1.46	14.91	13.31	0.84	0.55
7b	20/02	13:30 15:00	260°	13.74	12.08	0.88	1.23	16.96	15.18	0.94	0.48
8a	21/02	14:00 16:00	265°	12.22	10.69	0.81	1.51	15.59	13.99	0.85	0.41
9a	22/02	11:00 12:30	252°	10.48	9.05	0.75	2.46	13.62	12.04	0.83	0.94
9b	22/02	13:30 15:30	260°	13.53	11.98	0.82	0.87	17.10	15.29	0.96	0.51
Average (Geometric mean)							1.59	0.68			
							G.Mean 1.04 cm				

4.3 U2A Anemometer Results

The individual values of mean wind speed (1-minute average) and direction obtained at half-hourly intervals from the hilltop and airport U2A anemometers are tabulated in Tables B.20 to B.29 along with the corresponding speed-up ratios. These tables are presented on a day-to-day basis and include all the values obtained. For purposes of interpretation of the speed-up results, it is desirable to classify the values according to direction and to include only those values obtained during reasonably steady conditions (i.e., no major wind shifts, etc.). On this basis, the U2A systems provided 98 individual speed-up estimates for two basic wind directions (measured at the airport): $245^\circ \pm 10^\circ$ (91 values) and $220^\circ \pm 10^\circ$ (7 values). Table 6 summarizes these estimates on a run-to-run basis, giving the average speed-up and airport reference speed and direction for each run, together with the number of individual values from which the averages were obtained. The seven values from Run 6 are those which make up the 220° direction category, for which the speed-up is 1.64. The 91 values from all other runs make up the 245° category and yield an average speed-up of 1.40. This value is lower than that for the 220° direction, as expected, because of the steeper slope for the latter direction ($h/L \sim 0.31$ for 220° , ~ 0.23 for 245°).

Table 6 Summary of U2A anemometer speed-up estimates during steady conditions (hilltop of airport)

Date	Run Number	Time Period	No. of Observations	Average Speed-up	Average Direction (Airport)	Average Speed, ms^{-1} Airport
14/02/81	1	1200-1500	4	1.11	250	18.3
15/02/81	2	0900-1630	15	1.34	249	13.5
16/02/81	3	1300-1700	8	1.35	251	9.8
17/02/81	4	1000-1700	13	1.41	239	10.9
18/02/81	5	1000-1700	15	1.52	248	10.5
19/02/81	6	1330-1700	7	1.64	224	8.6
20/02/81	7	0900-1600	13	1.31	244	13.0
21/02/81	8	1130-1700	11	1.47	245	12.9
22/02/81	9	1000-1600	12	1.46	245	11.6

5. CONCLUSIONS

The Kettles Hill Experiment has provided an extensive set of data on spatial variations in near-surface mean wind and turbulence induced by a low hill. For some directions mean winds at the hilltop were increased by more than 60% over those measured upwind. The data are now being compared with the predictions of numerical and wind tunnel models of the flow over Kettles Hill (e.g. Walmsley et al., 1982, Teunissen et al., 1982) and will provide an excellent opportunity to evaluate and improve existing modelling capabilities.

6. ACKNOWLEDGEMENTS

A complete list of acknowledgements would be very long and almost certainly incomplete and hence will not be attempted. We would, however, like to extend our appreciation and thanks to Mr. & Mrs. Kettles and to Alberta Government Telephones for granting us access to their property, and to other landowners near the hill for tolerating our occasional intrusions. Bob Dobbs at Pincher Creek Airport and Ted Wilson in Lethbridge gave invaluable assistance with the local meteorology while Archie Black and his team at AES headquarters helped us by getting our equipment to the right place at the right time. Financial support for the experiment was provided by the Office of Energy Research and Development of the Department of Energy, Mines and Resources and by AES. Finally Evonna Mathis and John Walmsley took our rather long and muddled manuscript and produced the final version of the report. Many thanks to them and the many others who helped us with the experiment.

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APPENDIX A
CALIBRATION OF INSTRUMENTS

A.1 Wind Tunnel

Prior to and following the experiment, all of the cup anemometers were calibrated in the AES (Downsview) Boundary Layer Wind Tunnel. This facility is described in Teunissen and Flay (1981). Briefly, it is an open-circuit tunnel having a test section 18.3m long, 2.44m wide and 1.83m high. A six-bladed, fixed-pitch, axial (75 hp) fan at the downwind end draws air through the tunnel. The exhausted air is recirculated through the room in which the tunnel is housed. A honeycomb grid at the test section entrance reduces lateral non-uniformities in the test section. An anomaly in the flow, nevertheless, does occur in a horizontal plane 1.2m above the tunnel floor. At this height there is a prominent seam where two separate sheets of honeycomb material are butted. The wake from this produces a velocity defect of 5-10% across the tunnel at this height along most of the length of the test section, and this region of the flow must therefore be avoided when performing tests with the honeycomb installed. This may not have been the case during some of the first wind-tunnel calibrations of the cup anemometers and the velocity defect may have contributed to some anomalies on the calibration results (see below). The downstream location of the anemometers for all calibrations was 3-4m downstream of the honeycomb.

Boundary layers of approximately 8 cm depth (at the test station used) form along the length of the tunnel and reduce the usable measurement area to approximately 2.28m by 1.67m. It is worth noting that if this cross-section of the tunnel is too tightly packed with anemometers, the flow will be distorted to an extent which will result in uncertainties in the calibration. This may have been the case in our initial calibrations of both the Gill and Casella cup anemometers.

During a calibration run the air flow was adjusted to approximately the desired speed and held steady for a period of several minutes while measurements were taken. The velocity of the flow in the tunnel was measured

with a pitot-static tube (Airflow Developments) coupled to a Datametrics Electronic Manometer (Type 1018B). The pitot-static probe was mounted as close to the anemometer(s) as possible without interfering with the air flow. The flow speed was calculated using:

$$U = 37.82 \left[\frac{(273.2 + T_A) \Delta P}{P_A} \right]^{1/2} \quad . \quad A.1$$

In this formula, U is the flow speed in ms^{-1} , T_A is the ambient air temperature in $^{\circ}\text{C}$, P_A is the ambient barometric pressure in mbar and ΔP is the pitot-static differential pressure measured in inches of water. The air temperature was measured with a Digitec (United Systems Corporation) Model 251A digital thermometer and the barometric pressure with an R. Fuess Model G5411 aneroid barometer.

A.2 Gill UVW Anemometers

The Gill UVW three-component propeller anemometer consists of an orthogonal array of three propellers which are mounted on shafts connected to three independent tacho-generators. Ideally, the output from each generator is proportional to the velocity component parallel to the shaft or 'arm' and hence perpendicular to the plane in which each propeller rotates. In practice, this desired 'cosine' response of each unit is not perfect, and corrections must be iteratively applied using techniques such as those described by Horst (1973b) and Teunissen (1977). Two types of calibration are therefore required for each anemometer:

- i) a calibration of wind speed vs. output voltage for each arm for winds which are parallel to the propeller's axis of rotation;
- ii) a yaw calibration of actual anemometer output compared to the idealized value of $U \cos \theta$ for a wind of speed U approaching the unit from an angle θ relative to the arm. In principle, assuming no mutual interference effects of one propeller or mounting arm on another, this yaw calibration can be performed on a single unit (i.e., propeller-arm) mounted individually in the wind tunnel. In practice, it is preferable to mount the entire UVW assembly in the tunnel to obtain correction coefficients without the necessity of making this assumption. The latter approach was used in the present case.

Type (i) calibrations were performed in two stages. First, all tachogenerators were checked for RPM/voltage calibration prior to the experiment by using a constant-speed spinning motor to rotate the shafts at a fixed speed and measuring the corresponding output voltage. This bench test was repeated after the experiment on all units to ensure that no changes had occurred. The nominal output voltage at the test speed of 1800 rpm is 0.500 volts, and all units were within $\pm 5\text{mV}$ of this value before the experiment and had changed by less than $\pm 3\text{mV}$ ($\pm 0.6\%$) after it. Secondly, to obtain the actual wind speed/voltage calibration constants, six typical units were tested in the wind tunnel following the experiment (the propellers used were not available prior to the experiment). The results are plotted in Fig. A.1 and yield a calibration constant of 0.0568 v/ms^{-1} or $17.61 \text{ ms}^{-1}/\text{v}$ ($\pm 1\%$). This agrees exactly with the manufacturer's specification for this propeller-type (Model 8234) and is the value used for all units.

Type (ii) calibrations were performed on a single, typical UVW anemometer following the experiment. Since the anemometers were mounted in the field with the w-component vertically aligned, a similar alignment was used for the wind tunnel calibration of the horizontal components. That is, with the w-component normal to the wind tunnel floor, the entire unit was rotated about the vertical axis over an azimuthal range (θ of about 150° (the acceptable operational range of the anemometer to ensure no significant interference effects due to the propellers or the main propeller-arm support system)). Correction coefficients were then obtained by dividing the nominal output velocity at each angle ($= U \cos \theta$) by the actual output. Multiplication of these coefficients by 100 yielded the "HORCOR" values listed in Table A.1. These are listed as a function of $\cos \theta$ (rather than θ) for ease of computer application (Horst, 1973b). The corresponding "VERCOR" values in Table A were obtained for the vertical-component anemometer by performing pitch-tests at the typical azimuthal angle ($\theta = 45^\circ$) for which the approaching wind bisected the angle between the u and v arms. Typical computer algorithms for applying these coefficients can be found in Horst (1973b) or Teunissen (1977).

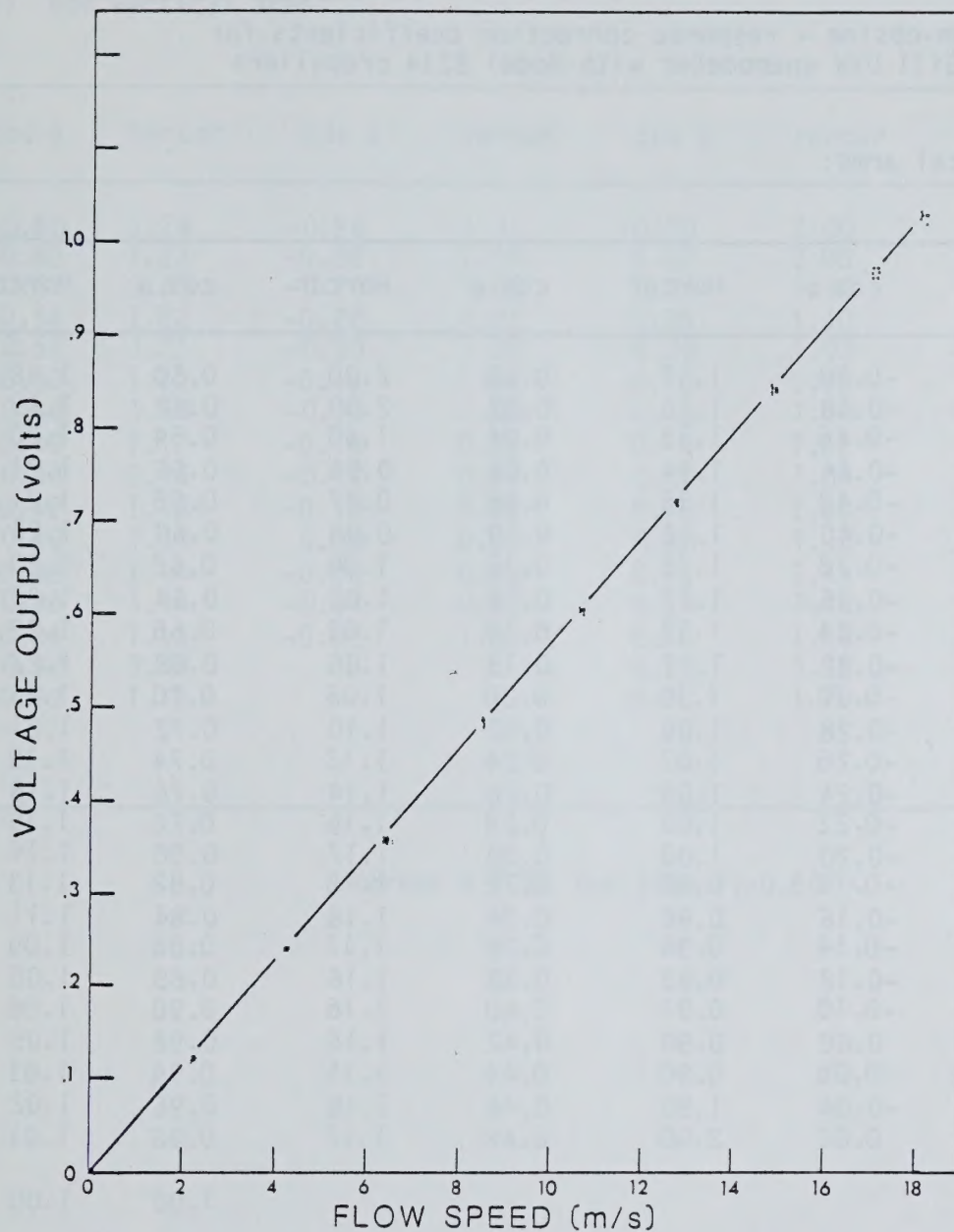


Figure A.1. Results of a typical wind tunnel calibration of six propeller anemometer units from Gill UVW anemometers (model 27004) with model 8234 polypropylene propellers. The anemometers were aligned parallel with the flow direction.

Table A.1

Non-cosine - response correction coefficients for
Gill UVW anemometer with Model 8234 propellers

(a) For horizontal arms:

cos θ	Horcor	cos θ	Horcor	cos θ	Horcor	cos θ	Horcor
-1.00	1.00	-0.50	1.17	0.00	2.00	0.50	1.18
-0.98	1.01	-0.48	1.16	0.02	2.00	0.52	1.19
-0.96	1.01	-0.46	1.15	0.04	1.50	0.54	1.20
-1.94	1.02	-0.44	1.14	0.06	0.96	0.56	1.21
-0.92	1.03	-0.42	1.13	0.08	0.97	0.58	1.21
-0.90	1.05	-0.40	1.12	0.10	0.98	0.60	1.22
-0.88	1.06	-0.38	1.12	0.12	1.00	0.62	1.23
-0.86	1.07	-0.36	1.12	0.14	1.02	0.64	1.23
-0.84	1.09	-0.34	1.12	0.16	1.03	0.66	1.23
-0.82	1.11	-0.32	1.11	0.18	1.06	0.68	1.22
-0.80	1.13	-0.30	1.10	0.20	1.08	0.70	1.21
-0.78	1.15	-0.28	1.09	0.22	1.10	0.72	1.21
-0.76	1.16	-0.26	1.07	0.24	1.12	0.74	1.19
-0.74	1.18	-0.24	1.05	0.26	1.14	0.76	1.18
-0.72	1.19	-0.22	1.03	0.28	1.16	0.78	1.16
-0.70	1.21	-0.20	1.00	0.30	1.17	0.80	1.14
-0.68	1.22	-0.18	0.98	0.72	1.18	0.82	1.13
-0.66	1.22	-0.16	0.96	0.34	1.18	0.84	1.11
-0.64	1.22	-0.14	0.94	0.36	1.17	0.86	1.09
-0.62	1.22	-0.12	0.93	0.38	1.16	0.88	1.08
-0.60	1.22	-0.10	0.91	0.40	1.16	0.90	1.06
-0.58	1.21	0.08	0.90	0.42	1.15	0.92	1.05
-0.56	1.20	-0.06	0.90	0.44	1.15	0.94	1.03
-0.54	1.19	-0.04	1.50	0.46	1.16	0.96	1.02
-0.52	1.18	0.02	2.00	0.48	1.17	0.98	1.01
						1.00	1.00

(b) For vertical arms:

cos θ	Vercor	cos θ	Vercor	cos θ	Vercor	cos θ	Vercor
-0.60	1.24	-0.28	1.11	0.00	2.00	0.32	1.20
-0.58	1.23	-0.26	1.10	0.02	2.00	0.34	1.20
-0.56	1.23	-0.24	1.08	0.04	1.50	0.36	1.19
-0.54	1.22	-0.22	1.07	0.06	1.10	0.38	1.19
-0.52	1.21	-0.20	1.05	0.08	1.02	0.40	1.18
-0.50	1.20	-0.18	1.02	0.10	0.99	0.42	1.18
-0.48	1.18	-0.16	1.00	0.12	1.00	0.44	1.18
-0.46	1.17	-0.14	0.98	0.14	1.02	0.46	1.19
-0.44	1.16	-0.12	0.95	0.16	1.04	0.48	1.20
-0.42	1.15	-0.10	0.92	0.18	1.06	0.50	1.22
-0.42	1.14	0.08	0.90	0.20	1.10	0.52	1.23
-0.38	1.14	-0.06	0.85	0.22	1.13	0.54	1.24
-0.36	1.14	-0.04	0.90	0.24	1.16	0.56	1.25
-0.34	1.13	-0.02	1.50	0.26	1.18	0.58	1.25
-0.32	1.13			0.28	1.19	0.60	1.25
-0.30	1.12			0.30	1.20		

Vercor = 1.25 for $|\cos \theta| > 0.60$

A.3 Gill Cup Anemometers

The Gill cup anemometers were calibrated in the wind tunnel once before the experiment and twice afterwards.

The first Gill cup anemometer calibration was performed prior to the field experiment. A "Dexion" frame was installed in the tunnel on which were mounted eight anemometers for simultaneous calibration. Such a large number of anemometers and the substantial mounting frame may have seriously deformed the flow in the tunnel. Unfortunately, it is not possible to determine any effects on individual anemometers and the calibration must be viewed with caution. The results of the first calibration are given in Table A.2.

The second wind tunnel calibration, performed on 1 May, 1981, gave rise to seemingly anomalous results which were subsequently discarded as unreliable. This calibration was performed in a manner similar to that of the first calibration.

A third and final wind tunnel calibration took place on 1 February 1982. For this trial, only two anemometers were placed in the tunnel simultaneously in order to remove the possibility of gross flow distortion. Each anemometer was mounted on its own slender stand and carefully placed to avoid the disturbance created by the horizontal seam in the honeycomb. The results of this calibration are given in Table A.3.

By comparing Tables A.2 and A.3, it can be seen that, for individual anemometers, the difference in calculated wind speed for an identical voltage output may be as large as 5%. This difference is mainly attributable to two sources. The first is physical degradation of the anemometers (especially bearings and generator brushes) after many revolutions at Kettles Hill and during the Casella/Gill comparison (see below). The second is errors due to flow distortion in the first calibration set-up. Since there is no way of knowing what these latter errors are, and since some of the anemometers evidently retained their original calibrations, it was decided to use the calibration coefficients of Table A.3 for subsequent processing of Gill cup anemometer data.

A.4 Casella Anemometers

The Casella anemometers were calibrated once before the experiment and twice after its completion.

The first calibration took place on 19 January 1981. In this trial, four anemometers were mounted simultaneously on the same "Dexion" frame that was used for the Gill cup anemometer calibration. As noted for the first Gill cup calibration, there is a possibility that the air flow around the anemometers was distorted sufficiently (by the large steel frame and large number of anemometers in the tunnel) to cause uncertainty in the derived calibration coefficients. It is also possible that the upper anemometers were in the wake of the seam in the honeycomb. The results of the calibration, which were done in the 5 to 15 m s⁻¹ flow speed range are shown in Table A.4. Pulses were counted over two five-minute intervals.

A second wind-tunnel calibration trial (after the experiment) took place on 18-19 March 1981. The anemometers were set up in a manner similar to that described for the first calibration except that two to five anemometers were mounted on the "Dexion" frame for a run. Again, there is a possibility that distortion of the flow introduced an unknown uncertainty into the results which are given in Table A.5. The calibration speeds varied from 10 to 17.5 m s⁻¹. Pulses were again counted over two five-minute intervals.

The third wind-tunnel calibration was performed on 11 February 1982. In order to minimize flow distortion, only two anemometers were placed in the tunnel simultaneously. These were mounted on the same slender stands used for the Gill cup anemometer calibrations and carefully placed to avoid the flow distortion caused by the horizontal seam in the aluminum honeycomb. The results of this calibration, in which pulses were counted over two two-minute intervals are given in Table A.6.

Table A.2 Coefficients for wind-tunnel calibration of Gill cup anemometers prior to the field experiment (first). The calibration equation is:

$$U(\text{m s}^{-1}) = a_1 E(\text{volts}) + a_0$$

where U is the flow velocity measured using the pitot-static tube and E is the measured anemometer output voltage; a_0 and a_1 are the coefficients derived from the calibration.

Gill Cup Anemometer at 3m				Gill Cup Anemometer at 6m		
10m	Ident.			Ident.		
Tower	Number	a_1	a_0	Number	a_1	a_0
1	12	-14.048	0.3499	11	-15.336	0.3289
2	10	-16.276	0.1756	9	-14.313	0.4221
3	6	-15.398	0.3765	5	-22.024	0.6364
4	3	-14.311	0.3747	2	-15.096	0.5099
5	14	-13.117	1.7850	17	-12.927	0.3923
6	16	-13.199	0.4833	15	-12.518	0.4811
7	19	-12.668	0.3579	18	-13.432	1.0083
8	23	-12.922	0.3899	20	-13.052	0.6321
9	22	-12.554	0.5179	21	-12.853	0.6000
10	13	-14.505	0.3661	7	-14.957	0.3395

Table A.3 Coefficients for wind-tunnel calibration of Gill cup anemometers on 01/02/82 (third). The calibration equation is:

$$U(m\ s^{-1}) = a_1 E(\text{volts}) + a_0$$

where U is the flow velocity measured using the pitot-static tube and E is the measured anemometer output voltage; a_0 and a_1 are the coefficients derived from the calibration. The numbers in brackets are the percentage differences between wind speeds (for a 1 volt anemometer output) calculated using the calibration coefficients of this table and those calculated using the coefficients of Table A.2.

Gill Cup Anemometer at 3m				Gill Cup Anemometer at 6m			
10m Tower	Ident. Number	a_1	a_0 Δ	Ident. Number	a_1	a_0 Δ	
1	12	-14.189	0.4840 (-1%)	11	-15.344	0.6901 (-2%)	
2	10	-15.408	0.3704 (4%)	9	-14.193	0.4908 (0%)	
3	6	-15.287	0.6009 (-1%)	5	-22.303	0.4448 (0%)	
4	3	-14.374	0.4570 (-1%)	2	-15.463	0.5598 (-3%)	
5	14	13.268	2.0772 (-3%)	17	-13.031	0.3265 (0%)	
6	16	-12.632	0.3742 (-5%)	15	-12.982	0.3937 (-3%)	
7	19	-12.501	0.4617 (1%)	18	-13.242	0.4773 (5%)	
8	23	-12.637	0.2559 (3%)	20	-12.790	0.3246 (4%)	
9	22	-12.782	0.3068 (0%)	21	-13.808	0.1915 (-4%)	
10	13	-14.509	0.6090 (-2%)	7	-15.103	0.5156 (-2%)	

It can be seen from Tables A.4 and A.5 that discrepancies of up to 8% occur in the calibrations performed at the two times. Between the first and second calibration, it might be expected that a small difference occur due to the wearing of the anemometer bearings during the course of the experiment. (Simply by listening to the "clattering" of some of the anemometers, this would seem to have been the case.) However, for most of the anemometers, the negative percentage change demonstrates that the calibrations have shifted in the opposite sense. Furthermore, a comparison of Tables A.4 and A.6 (i.e. percentage figures in brackets) suggests that the anemometers have indeed suffered from worn bearings. (It is important to note here that Casellas A,B,D,E and H were used in a Casella/Gill intercomparison experiment between the second and third wind tunnel calibrations and as a result may show considerably more wear on the bearings than the other Casella anemometers.)

While the calibrations of Table A.6 were done with the most care, it is not known to what extent the bearings had degraded when the calibrations were done. Furthermore, a lack of consistency between Tables A.4, A.5 and A.6 is evident. Therefore, more calibration data must be considered, as described in the following section.

Table A.4 Coefficients for wind-tunnel calibration of Casella anemometers on 19/01/81 (first). The calibration equation is:

$$U(\text{ms}^{-1}) = b_0 + b_1 C(\text{counts/min})$$

where U is the flow velocity measured using the pitot-static tube and C is the number of voltage pulses (i.e. counts) per minute from the anemometer; b_0 and b_1 are the coefficients derived from the calibration.

Casella Anemometer	b_0	b_1	Casella Anemometer	b_0	b_1
A	0.55	0.02150	F	0.65	0.02188
B	0.63	0.02295	G	0.70	0.02178
C	0.50	0.02260	H	0.65	0.02220
D	0.70	0.02180	I	0.56	0.02313
E	0.53	0.02265	J	0.47	0.02262

Table A.5 Coefficients for wind-tunnel calibration of Casella anemometers on 18-19/03/81 (second). The calibration equation is as given on Table A.4. The numbers in brackets are the percentage differences between wind speeds (for a pulse count of 600 min^{-1}) calculated using the calibration coefficients of this Table and those calculated using the coefficients of Table A.4.

Casella Anemometer	b_0	b_1	Δ	Casella Anemometer	b_0	b_1	Δ
A	0.63	.0214	(0%)	F	0.72	.0218	(0%)
B	0.93	.0217	(-3%)	G	1.03	.0215	(1%)
C	0.63	.0216	(-3%)	H	0.80	.0208	(-5%)
D	0.67	.0206	(-6%)	I	1.20	.0220	(0%)
E	0.64	.0223	(-1%)	J	1.14	.0197	(-8%)

A.5 Casella/Gill 8.3 Hilltop Field Intercomparison

On three different occasions (17/02/81, 22/02/81 and 23/02/81) during the Kettles Hill field experiment, a linear array (normal to the wind with about 2m spacing) of all ten 3m-Casella towers was erected adjacent to 10m-Gill tower number eight. The 3m altitude Gill cup anemometer (referred to as Gill 8.3) was carefully monitored while Casella counts were taken over a period of 20 minutes to one hour, depending on the day. The results of this "hilltop" calibration are shown in Fig. A.2 for two representative anemometers, A and G. Also shown on the graphs are the results of the three wind tunnel calibrations.

It can be seen from Fig. A.2 that the data from the first two wind-tunnel calibrations and the "hilltop" calibrations agree fairly well. Only the third wind-tunnel calibration shows significant disagreement with the other data. This may be due to worn bearings (especially in the case of Casella A) or the difference in technique for the third calibration.

Because there was reasonable agreement between the "hilltop" and wind-tunnel data (i.e. first two calibrations at least), it was decided to choose subjectively a calibration curve which would agree best with all these data (excluding the third wind tunnel calibration for reasons noted above). These "composite" calibrations are shown in Fig. A.2 for Casella anemometers A and G. Fig. A.2 and similar graphs for the remaining Casella anemometers were used to draw up Table A.7, the calibration coefficients for the "composite" calibrations. These are the calibrations that were used throughout this report.

It is worthwhile to remark here that during the examination of the wind-tunnel and "hilltop" calibration data, Casella anemometers A, E and G were judged good, anemometers H and D were judged fair and the remaining (B,C,F,I,J) were judged poor in overall consistency. The data used for these evaluations were independent of any calibration coefficients.

In spite of all our efforts to reconcile calibration differences we still found differences between Casella and Gill speed-up results on occasions when measurements were made at essentially the same location with both systems

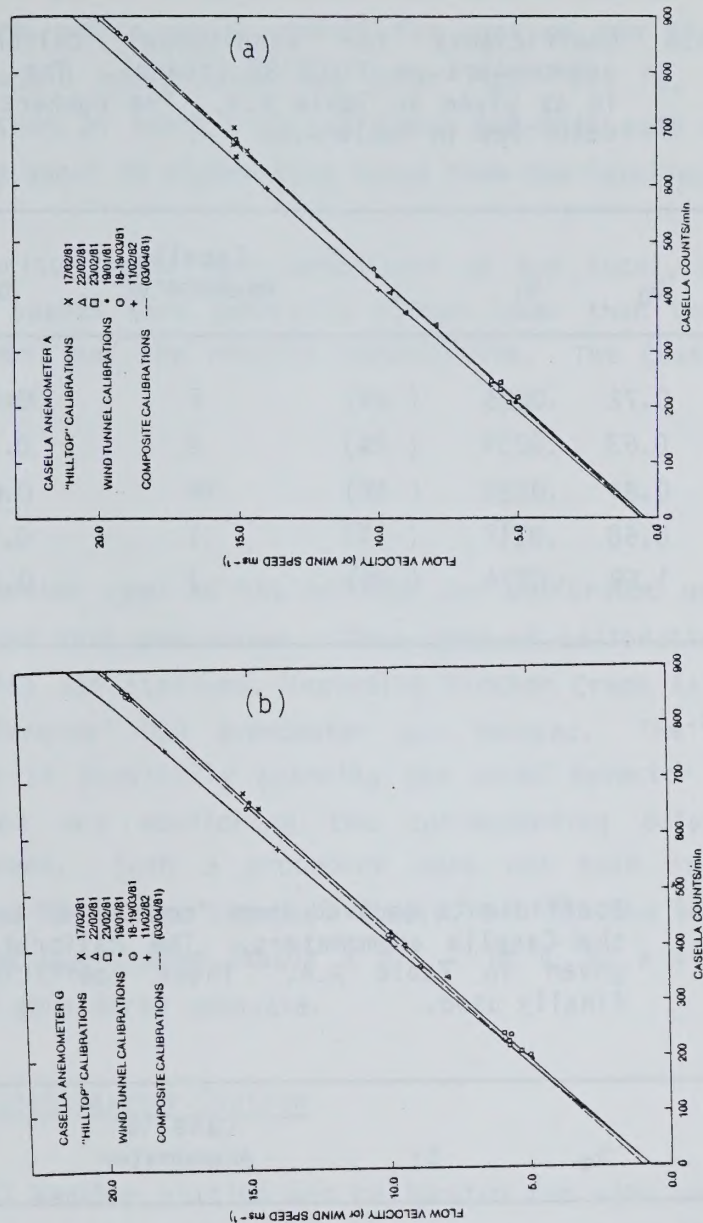


Figure A.2. Sample "hilltop" calibrations. The individual points derived from an in situ comparison of the Casella anemometers and the Gill (8.3) anemometer are shown along with the data and calibration curves from the three wind-tunnel trials (Tables A.4, A.5 and A.6). The "composite calibration" curve (dashed line) is a subjectively derived calibration which includes the "hilltop" calibration information. (a) Casella anemometer A; (b) Casella anemometer G.

Table A.6 Coefficients for wind-tunnel calibration of Casella anemometers on 11/02/82 (third). The calibration equation is as given in Table A.4. The numbers in brackets are as described in Table A.5.

Casella Anemometer	b_0	b_1	Δ	Casella Anemometer	b_0	b_1	Δ
*A	0.72	.0225	(6%)	F	0.73	.0226	(4%)
*B	0.63	.0234	(2%)	G	0.71	.0230	(5%)
C	0.84	.0229	(4%)	*H	0.66	.0219	(-1%)
*D	0.68	.0217	(-1%)	I	0.70	.0234	(2%)
*E	1.59	.0224	(6%)	J	0.71	.0218	(-2%)

* See text.

Table A.7 Coefficients derived from "composite" calibration curves of the Casella anemometers. The calibration equation is as given in Table A.4. These coefficients are the ones finally used.

Casella Anemometer	b_0	b_1	Casella Anemometer	b_0	b_1
A	0.62	.0213	F	0.71	.0218
B	1.00	.0217	G	1.02	.0215
C	1.22	.0210	H	0.77	.0208
D	0.61	.0207	I	1.03	.0219
E	0.82	.0224	J	1.13	.0197

Comparative data are given in Table A.8. For Runs 5a and 5b the anemometers were about 4m apart, which could account for part of the 6% differences in speed-up, but it would appear from the other runs (6a, 7a, 7b), where the towers were less than 2m apart that, at least for this pair of anemometers, the Gill values are about 3% higher than those from the Casella.

Further comparison tests were undertaken at our local, Woodbridge test site but the wind speeds were generally rather lower than those encountered during the experiment and the results inconclusive. The Casella anemometers have now been retired.

A.6 U2A Anemometer

The U2A anemometer used at the hilltop was calibrated using a standard AES U2A test kit and test procedures. This type of calibration is performed routinely at all AES U2A stations, including Pincher Creek Airport where the corresponding 'reference' U2A anemometer was located. The test procedure consists basically of physically spinning the speed detector to a constant, predetermined speed and monitoring the corresponding output voltage or indicated wind speed. Such a procedure does not take into account the aerodynamic calibration of the cupwheel itself, but for the accuracy normally obtainable with the U2A system (about $\pm 0.5 - 1 \text{ m s}^{-1}$), a visual inspection of the cupwheel is considered adequate.

A.7 M.R.I. Mechanical Weather Station

The Mechanical Weather station was calibrated for wind speed in the wind tunnel on 07/04/81 by letting it record wind run at constant flow speeds of 3, 6, 9 and 12 m s^{-1} for approximately one hour each. From these data, a calibration curve for the device was derived.

$$U(\text{m s}^{-1}) = 1.00 + 1.46 U_{\text{MRI}}(\text{m s}^{-1})$$

where U is the measured flow velocity in the tunnel and U_{MRI} is the averaged velocity calculated from the mechanical weather station's strip chart by dividing the wind run in metres by the elapsed time in seconds. Wind direction and temperature were not calibrated. The factor 1.46 arises as a result of the use of a non-standard strip chart and does not indicate a problem with the anemometer.

Table A.8 Comparisons between Casella and Gill measured speed-ups at 3m on occasions when systems were collocated.

Run	10m Tower	Gill Cup System	Casella System	Speed-up	
				Gill	Casella
5a	3	6	D	1.11	1.05
5b	3	6	D	1.05	0.99
6a	8	23	B	1.62	1.56
7a	8	23	B	1.22	1.18
7b	8	23	B	1.25	1.21

A.8 Sonic Anemometer-Thermometer

The sonic anemometer is an absolute instrument in that it requires no direct calibration in the field or laboratory in order to produce the desired output. Simple, self-contained electronic adjustments are sufficient and these were carried out at appropriate times during the experiment.

A.9 AIRsonde Systems

Calibrations of the pressure sensor for individual sondes were supplied by the manufacturer and entered into the micro-processor-based ground station prior to flight. Thermistor sensors (wet and dry bulb) were matched and standard calibration coefficients were used in the analysis.

APPENDIX B

DATA

B.1 Introduction

The following sections summarize the data collected during the various experimental runs. Tables 2-4 and Figures 8-18 provide additional information.

B.2 10m Tower Data

Figures 5 and 6 and Table 2 describe the locations of the 10m towers. Table 4 gives the times of operation of the data loggers recording the 10m tower data.

The 10m towers provided information at three levels. At 10m, the Gill UVW anemometer measured wind speed and direction, while at 6m and 3m (nominal) wind speed was measured by Gill cup anemometers. Tables B.1 through B.6 summarize the information on a run-by-run basis. They also give the speed-up, based on reference 10m tower 1.

The data logging rate for each run is given in Table 4 and in the individual table captions. The averaging interval starts at the time shown in the table and extends to the next sequential time. The averaging interval is constant for a given run. The start times and lengths of the averaging intervals have been chosen to correspond to those used for the 3m tower system in each run. Each entry in the a-series (wind speed) tables consists of four numbers. The upper number is the horizontal wind direction (direction from which the wind is blowing). The second number represents the total wind speed. These two pieces of information are from the 10m Gill UVW anemometer. The third figure is wind speed calculated from the 6m Gill cup anemometer data while the bottom one is wind speed from the 3m Gill cup anemometer. The b-series (speed-up) tables are analogous to the wind speed tables except that the speed-up (calculated as wind speed at the given tower and height divided by wind speed at tower 1 and the given height) is recorded in place of the wind speed, except for tower 1 where the actual wind speed re-appears.

Table B.1a

Averaged wind directions and speeds for 10m towers on 18/02/81. The averaging interval is 15 min. The sensors were sampled at 0.5s intervals. All speeds are in m s^{-1} .

18/ 2/81

MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR10
1300	Drn	257.	260.	260.	259.	254.	255.	259.	262.	260.	N/A
	10m	10.2	9.4	11.2	13.1	13.1	14.5	13.9	14.4	13.9	N/A
	6m	10.4	10.1	10.4	13.2	13.8	14.8	13.4	14.3	14.5	12.8
	3m	9.1	N/A	10.3	12.2	12.6	13.4	12.6	12.7	12.3	12.0
1315	Drn	262.	266.	265.	263.	257.	257.	261.	262.	259.	N/A
	10m	10.2	9.5	10.9	12.9	12.8	13.8	13.2	13.6	12.7	N/A
	6m	10.4	10.2	10.0	13.1	13.4	14.1	12.9	13.5	13.7	12.5
	3m	9.2	N/A	10.1	12.1	12.5	12.7	12.1	12.1	11.6	11.6
1330	Drn	258.	261.	260.	259.	254.	255.	259.	261.	258.	N/A
	10m	10.9	10.6	11.7	14.1	14.6	15.3	14.7	15.2	13.8	N/A
	6m	11.1	11.2	10.8	14.3	15.0	15.7	14.4	15.1	14.9	13.9
	3m	9.8	N/A	10.9	13.3	14.1	14.1	13.4	13.3	12.6	12.8
1345	Drn	249.	251.	251.	251.	247.	247.	251.	252.	248.	N/A
	10m	10.9	10.7	11.6	14.3	14.8	15.9	14.9	15.2	14.4	N/A
	6m	11.2	11.3	10.6	14.4	15.4	16.1	14.6	15.2	15.7	13.8
	3m	9.8	N/A	10.8	13.4	14.5	14.6	13.5	13.4	13.3	12.7
1400	Drn	250.	251.	252.	253.	247.	248.	251.	253.	248.	N/A
	10m	11.2	10.8	11.7	14.4	14.3	15.4	14.8	15.1	13.8	N/A
	6m	11.5	11.4	10.7	14.6	15.2	15.6	14.5	15.2	15.6	13.8
	3m	10.1	N/A	11.0	13.6	14.4	14.0	13.3	13.4	13.2	12.6
1415	Drn	256.	257.	257.	257.	251.	252.	255.	257.	252.	N/A
	10m	11.1	10.1	11.6	13.5	13.1	14.3	14.1	14.7	13.1	N/A
	6m	11.3	10.7	10.5	13.7	14.1	14.5	13.9	14.6	14.9	13.3
	3m	9.9	N/A	10.8	12.8	13.4	13.2	12.8	12.9	12.7	12.4
1430	Drn	255.	257.	258.	257.	251.	253.	256.	258.	253.	N/A
	10m	11.8	11.0	12.2	14.5	14.0	15.2	14.9	15.3	13.5	N/A
	6m	12.0	11.4	10.8	14.7	15.0	15.5	14.8	15.3	15.2	13.7
	3m	10.5	N/A	11.4	13.7	14.3	14.0	13.6	13.5	12.9	12.7
1445	Drn	258.	259.	257.	256.	250.	252.	256.	257.	254.	N/A
	10m	11.1	10.1	11.7	13.8	13.4	15.1	14.9	15.3	13.4	N/A
	6m	11.4	10.6	9.9	14.0	14.8	15.3	14.9	15.3	15.0	14.0
	3m	10.0	N/A	10.8	13.0	14.2	13.8	13.6	13.6	12.7	13.0
1500	Drn	259.	261.	261.	260.	253.	255.	258.	260.	256.	N/A
	10m	11.6	10.7	11.9	14.0	13.7	14.9	14.7	15.0	13.7	N/A
	6m	11.9	11.2	10.1	14.2	14.8	15.1	14.7	14.9	15.4	13.9
	3m	10.5	N/A	11.0	13.3	14.0	13.7	13.4	13.3	13.0	12.8
1515	Drn	254.	254.	253.	253.	248.	250.	253.	255.	251.	N/A
	10m	12.0	11.4	12.3	15.0	15.1	16.1	15.7	16.1	14.4	N/A
	6m	12.2	11.9	10.2	15.1	15.9	16.4	15.6	16.1	16.1	14.8
	3m	10.7	N/A	11.3	14.1	15.2	14.8	14.1	14.3	13.7	13.6
1530	Drn	256.	253.	253.	253.	248.	250.	253.	255.	251.	N/A
	10m	12.2	10.9	12.5	15.2	15.2	16.3	16.0	16.3	14.7	N/A
	6m	12.3	11.5	10.7	15.3	15.9	16.5	16.1	16.3	16.3	14.6
	3m	10.6	N/A	11.4	14.3	15.4	14.7	14.6	14.4	13.8	13.8

Table B.1a (cont'd.)

18/ 2/81

MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR10
1545	Drn	253.	252.	253.	252.	247.	248.	252.	253.	249.	N/A
	10m	13.3	12.4	13.4	16.5	16.6	17.7	17.3	17.6	16.3	N/A
	6m	13.5	13.0	11.9	16.5	17.5	18.1	17.2	17.6	17.5	15.7
	3m	12.0	N/A	12.4	15.4	16.7	16.3	15.5	15.2	14.7	14.5
1600	Drn	256.	256.	255.	255.	248.	250.	253.	254.	251.	N/A
	10m	13.1	12.6	14.1	16.8	16.2	17.5	17.2	17.6	16.7	N/A
	6m	13.3	13.0	12.8	16.9	17.2	17.9	17.1	17.5	18.0	16.0
	3m	11.7	N/A	12.9	15.7	16.4	16.1	15.4	15.4	15.1	14.6
1615	Drn	255.	257.	257.	256.	250.	252.	255.	257.	254.	N/A
	10m	14.2	11.6	13.4	15.9	15.8	16.7	16.4	16.6	15.1	N/A
	6m	14.3	12.0	12.4	16.1	16.5	17.0	16.4	16.5	16.5	15.6
	3m	12.7	N/A	12.5	14.9	15.6	15.2	14.8	14.5	13.9	14.4
1630	Drn	259.	261.	260.	259.	253.	255.	258.	259.	255.	N/A
	10m	11.2	10.7	11.7	14.1	14.0	14.8	14.6	14.8	13.7	N/A
	6m	11.4	11.1	10.6	14.2	15.0	15.0	14.6	14.7	15.3	13.4
	3m	10.0	N/A	10.8	13.2	14.3	13.5	13.3	13.1	13.0	12.4
1645	Drn	260.	262.	261.	259.	254.	256.	258.	260.	257.	N/A
	10m	11.9	12.2	12.9	15.7	15.8	16.5	16.6	17.2	15.5	N/A
	6m	12.0	12.4	11.7	15.7	16.7	16.7	16.5	17.1	16.9	15.5
	3m	10.5	N/A	11.8	14.6	15.8	15.0	14.9	15.0	14.2	14.3

Table B.1b Same as B.1a for tower 1. For all other towers speed-up is shown in place of speed.

18/ 2/81

MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR10
1300	Drn	257.	260.	260.	259.	254.	255.	259.	262.	260.	N/A
	10m	10.2	0.93	1.10	1.29	1.29	1.43	1.36	1.41	1.37	N/A
	6m	10.4	0.97	1.00	1.26	1.32	1.42	1.28	1.37	1.39	1.23
	3m	9.1	N/A	1.13	1.34	1.38	1.47	1.38	1.39	1.35	1.32
1315	Drn	262.	266.	265.	263.	257.	257.	261.	262.	259.	N/A
	10m	10.2	0.93	1.07	1.26	1.26	1.36	1.30	1.33	1.24	N/A
	6m	10.4	0.97	0.96	1.25	1.28	1.35	1.23	1.30	1.32	1.20
	3m	9.2	N/A	1.09	1.31	1.35	1.38	1.31	1.31	1.26	1.26
1330	Drn	258.	261.	260.	259.	254.	255.	259.	261.	258.	N/A
	10m	10.9	0.98	1.08	1.30	1.34	1.40	1.35	1.39	1.27	N/A
	6m	11.1	1.00	0.97	1.28	1.35	1.41	1.29	1.36	1.34	1.25
	3m	9.8	N/A	1.11	1.36	1.45	1.44	1.37	1.36	1.29	1.31
1345	Drn	249.	251.	251.	251.	247.	247.	251.	252.	248.	N/A
	10m	10.9	0.99	1.06	1.32	1.36	1.46	1.37	1.40	1.33	N/A
	6m	11.2	1.01	0.95	1.29	1.38	1.45	1.31	1.36	1.41	1.23
	3m	9.8	N/A	1.10	1.38	1.48	1.50	1.38	1.38	1.36	1.30
1400	Drn	250.	251.	252.	253.	247.	248.	251.	253.	248.	N/A
	10m	11.2	0.96	1.04	1.28	1.28	1.37	1.32	1.35	1.23	N/A
	6m	11.5	0.99	0.93	1.27	1.32	1.35	1.26	1.32	1.35	1.20
	3m	10.1	N/A	1.09	1.35	1.43	1.39	1.32	1.33	1.31	1.26
1415	Drn	256.	257.	257.	257.	251.	252.	255.	257.	252.	N/A
	10m	11.1	0.91	1.05	1.22	1.19	1.30	1.28	1.33	1.19	N/A
	6m	11.3	0.95	0.93	1.21	1.24	1.28	1.23	1.29	1.32	1.18
	3m	9.9	N/A	1.10	1.30	1.36	1.33	1.30	1.30	1.29	1.25
1430	Drn	255.	257.	258.	257.	251.	253.	256.	258.	253.	N/A
	10m	11.8	0.93	1.03	1.23	1.19	1.29	1.27	1.30	1.15	N/A
	6m	12.0	0.95	0.90	1.22	1.25	1.29	1.23	1.27	1.26	1.14
	3m	10.5	N/A	1.08	1.30	1.36	1.33	1.29	1.29	1.23	1.21
1445	Drn	258.	259.	257.	256.	250.	252.	256.	257.	254.	N/A
	10m	11.1	0.91	1.06	1.25	1.21	1.37	1.35	1.38	1.22	N/A
	6m	11.4	0.94	0.87	1.23	1.30	1.34	1.31	1.35	1.32	1.23
	3m	10.0	N/A	1.08	1.29	1.41	1.38	1.36	1.36	1.27	1.29
1500	Drn	259.	261.	261.	260.	253.	255.	258.	260.	256.	N/A
	10m	11.6	0.92	1.03	1.21	1.18	1.28	1.27	1.29	1.18	N/A
	6m	11.9	0.94	0.85	1.19	1.24	1.28	1.24	1.26	1.29	1.17
	3m	10.5	N/A	1.05	1.26	1.34	1.30	1.28	1.27	1.24	1.22
1515	Drn	254.	254.	253.	253.	248.	250.	253.	255.	251.	N/A
	10m	12.0	0.95	1.02	1.25	1.26	1.34	1.31	1.34	1.20	N/A
	6m	12.2	0.98	0.84	1.24	1.30	1.34	1.28	1.32	1.32	1.21
	3m	10.7	N/A	1.06	1.31	1.42	1.38	1.32	1.34	1.28	1.27
1530	Drn	256.	253.	253.	253.	248.	250.	253.	255.	251.	N/A
	10m	12.2	0.90	1.03	1.25	1.25	1.34	1.31	1.34	1.21	N/A
	6m	12.3	0.93	0.87	1.24	1.29	1.34	1.30	1.32	1.32	1.18
	3m	10.6	N/A	1.08	1.34	1.45	1.39	1.37	1.35	1.30	1.28

Table B.1b (cont'd.)

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MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR10
1545	Dnn	253.	252.	253.	252.	247.	248.	252.	253.	249.	N/A
	10m	13.3	0.94	1.01	1.24	1.25	1.33	1.30	1.33	1.23	N/A
	6m	13.5	0.96	0.88	1.22	1.29	1.34	1.27	1.30	1.30	1.16
	3m	12.0	N/A	1.04	1.29	1.40	1.36	1.29	1.27	1.23	1.21
1600	Dnn	256.	256.	255.	255.	248.	250.	253.	254.	251.	N/A
	10m	13.1	0.96	1.07	1.28	1.23	1.33	1.31	1.34	1.27	N/A
	6m	13.3	0.98	0.96	1.28	1.30	1.35	1.29	1.32	1.36	1.20
	3m	11.7	N/A	1.11	1.35	1.40	1.38	1.32	1.32	1.30	1.26
1615	Dnn	255.	257.	257.	256.	250.	252.	255.	257.	254.	N/A
	10m	14.2	0.81	0.94	1.12	1.11	1.18	1.16	1.17	1.06	N/A
	6m	14.3	0.84	0.86	1.12	1.16	1.19	1.14	1.15	1.15	1.09
	3m	12.7	N/A	0.99	1.18	1.23	1.20	1.17	1.15	1.10	1.14
1630	Dnn	259.	261.	260.	259.	253.	255.	258.	259.	255.	N/A
	10m	11.2	0.95	1.05	1.26	1.25	1.33	1.31	1.32	1.23	N/A
	6m	11.4	0.97	0.93	1.25	1.32	1.32	1.29	1.30	1.35	1.18
	3m	10.0	N/A	1.08	1.32	1.43	1.35	1.33	1.31	1.30	1.24
1645	Dnn	260.	262.	261.	259.	254.	256.	258.	260.	257.	N/A
	10m	11.9	1.03	1.08	1.32	1.33	1.39	1.40	1.45	1.31	N/A
	6m	12.0	1.03	0.98	1.31	1.39	1.40	1.38	1.43	1.41	1.30
	3m	10.5	N/A	1.12	1.39	1.51	1.42	1.42	1.42	1.35	1.36

Table B.2a Averaged wind directions and speeds for 10m towers on 18/02/81. The averaging interval is 15 min. The sensors were sampled at 0.5s intervals. All speeds are in m s^{-1} . (Note: the data used to synthesize these averages are identical to those used for Table B.1. The only difference is that the start time for averaging has been shifted to correspond with that of the 3m tower system for run 5b.)

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MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR10
1255	Drrn	255.	257.	258.	257.	252.	252.	256.	259.	257.	N/A
	10m	9.8	9.2	10.8	12.7	12.6	14.0	13.3	14.0	15.3	N/A
	6m	10.2	9.9	10.0	12.8	13.4	14.2	12.9	14.1	15.8	12.3
	3m	8.9	N/A	10.0	11.8	12.2	12.9	12.3	12.4	14.0	11.7
1310	Drrn	262.	266.	265.	263.	257.	258.	262.	263.	260.	N/A
	10m	10.3	9.4	11.1	13.0	13.0	14.0	13.3	13.5	12.9	N/A
	6m	10.5	10.1	10.3	13.1	13.5	14.3	12.9	13.4	13.7	12.6
	3m	9.2	N/A	10.2	12.1	12.5	12.8	12.1	12.0	11.6	11.7
1325	Drrn	259.	262.	262.	260.	255.	256.	260.	262.	258.	N/A
	10m	10.9	10.4	11.4	13.9	14.1	14.9	14.4	14.8	13.4	N/A
	6m	11.2	11.0	10.6	14.1	14.6	15.4	14.1	14.8	14.5	13.5
	3m	9.9	N/A	10.6	13.1	13.6	13.9	13.1	13.1	12.3	12.5
1340	Drrn	251.	254.	254.	254.	250.	250.	253.	255.	251.	N/A
	10m	10.9	11.0	11.9	14.6	15.0	15.9	15.1	15.5	14.7	N/A
	6m	11.2	11.5	11.0	14.7	15.6	16.2	14.8	15.5	15.9	14.2
	3m	9.8	N/A	11.1	13.7	14.7	14.6	13.7	13.6	13.3	13.0
1355	Drrn	250.	251.	251.	252.	246.	248.	251.	253.	248.	N/A
	10m	11.0	10.9	11.6	14.2	14.6	15.6	14.8	15.1	13.7	N/A
	6m	11.3	11.4	10.6	14.3	15.3	15.8	14.6	15.1	15.4	13.8
	3m	9.9	N/A	10.8	13.3	14.4	14.2	13.4	13.4	13.1	12.7
1410	Drrn	255.	254.	255.	255.	248.	249.	252.	254.	250.	N/A
	10m	11.2	10.1	11.6	13.8	13.3	14.6	14.4	15.0	13.6	N/A
	6m	11.5	10.8	10.6	14.0	14.2	14.8	14.1	14.9	15.3	13.6
	3m	10.0	N/A	10.9	13.1	13.5	13.4	13.0	13.2	13.0	12.5
1425	Drrn	256.	259.	258.	258.	253.	254.	257.	259.	254.	N/A
	10m	11.2	10.5	11.8	14.1	13.5	14.6	14.2	14.5	12.9	N/A
	6m	11.5	11.0	10.7	14.2	14.5	14.8	14.1	14.5	14.6	13.2
	3m	10.1	N/A	11.1	13.2	13.8	13.4	12.9	12.8	12.5	12.2
1440	Drrn	255.	257.	256.	255.	249.	251.	255.	257.	254.	N/A
	10m	11.7	10.5	12.0	14.1	13.9	15.4	15.3	15.7	13.7	N/A
	6m	11.9	11.1	10.3	14.3	15.3	15.6	15.1	15.7	15.3	14.0
	3m	10.4	N/A	11.2	13.2	14.6	14.0	13.8	13.9	12.9	13.0
1455	Drrn	260.	261.	261.	259.	253.	255.	258.	259.	255.	N/A
	10m	11.0	10.7	11.9	13.9	13.3	15.0	14.8	15.2	13.8	N/A
	6m	11.3	11.1	10.0	14.1	14.6	15.2	14.8	15.2	15.5	14.2
	3m	10.1	N/A	10.9	13.2	13.9	13.7	13.5	13.6	13.1	13.2
1510	Drrn	255.	256.	255.	255.	250.	252.	255.	257.	253.	N/A
	10m	12.1	11.2	12.1	14.7	14.3	15.4	15.1	15.4	13.8	N/A
	6m	12.4	11.7	10.1	14.8	15.2	15.7	15.1	15.4	15.4	13.9
	3m	10.9	N/A	11.1	13.7	14.6	14.2	13.7	13.7	13.1	12.7
1525	Drrn	256.	254.	254.	253.	248.	249.	252.	254.	249.	N/A
	10m	12.3	10.8	12.3	15.0	15.4	16.5	16.1	16.2	14.7	N/A
	6m	12.4	11.4	10.2	15.1	16.1	16.7	16.1	16.2	16.3	14.9
	3m	10.7	N/A	11.2	14.1	15.4	15.0	14.6	14.3	13.9	13.8

Table B.2a (cont'd.)

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MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR 10
1540	Drn	253.	251.	253.	253.	247.	249.	253.	254.	250.	N/A
	10m	12.6	12.1	13.3	16.4	16.2	17.3	16.9	17.5	15.9	N/A
	6m	12.9	12.7	11.7	16.4	17.0	17.7	16.8	17.5	17.2	15.4
	3m	11.4	N/A	12.3	15.2	16.3	15.8	15.2	15.2	14.4	14.3
1555	Drn	255.	254.	254.	254.	247.	249.	252.	254.	250.	N/A
	10m	13.3	12.5	13.6	16.5	16.2	17.5	17.3	17.5	16.7	N/A
	6m	13.4	12.9	12.3	16.6	17.3	17.8	17.2	17.4	18.1	15.9
	3m	11.8	N/A	12.5	15.4	16.4	16.1	15.6	15.2	15.2	14.6
1610	Drn	257.	258.	257.	256.	250.	252.	254.	256.	253.	N/A
	10m	13.9	12.1	14.0	16.3	15.9	16.9	16.5	17.0	16.0	N/A
	6m	14.0	12.5	12.8	16.4	16.7	17.3	16.5	16.8	17.2	15.7
	3m	12.2	N/A	12.9	15.2	15.8	15.3	14.9	14.8	14.6	14.4
1625	Drn	256.	259.	258.	257.	251.	254.	257.	258.	255.	N/A
	10m	12.4	11.1	12.7	15.4	15.6	16.0	15.7	15.6	13.9	N/A
	6m	12.6	11.6	11.5	15.5	16.5	16.3	15.7	15.5	15.5	14.4
	3m	11.2	N/A	11.8	14.4	15.5	14.7	14.2	13.7	13.2	13.4
1640	Drn	261.	262.	262.	260.	254.	255.	258.	260.	257.	N/A
	10m	10.9	10.9	11.7	14.0	14.6	15.1	15.2	15.7	14.4	N/A
	6m	11.0	11.1	10.7	14.1	15.5	15.3	15.2	15.7	15.8	14.6
	3m	9.6	N/A	10.8	13.1	14.7	13.8	13.7	13.9	13.3	13.4

Table B.2b Same as B.2a for tower 1. For all other towers speed-up is shown in place of speed.

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MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR10
1255	Dnn	255.	257.	258.	257.	252.	252.	256.	259.	257.	N/A
	10m	9.8	0.93	1.10	1.29	1.29	1.42	1.35	1.43	1.55	N/A
	6m	10.2	0.98	0.98	1.26	1.32	1.40	1.27	1.38	1.56	1.21
	3m	8.9	N/A	1.12	1.33	1.38	1.46	1.38	1.40	1.53	1.31
1310	Dnn	262.	266.	265.	263.	257.	258.	262.	263.	260.	N/A
	10m	10.3	0.91	1.08	1.26	1.26	1.36	1.29	1.31	1.25	N/A
	6m	10.5	0.96	0.98	1.24	1.28	1.36	1.23	1.28	1.30	1.19
	3m	9.2	N/A	1.11	1.31	1.36	1.39	1.32	1.30	1.26	1.27
1325	Dnn	259.	262.	262.	260.	255.	256.	260.	262.	258.	N/A
	10m	10.9	0.95	1.05	1.27	1.29	1.37	1.31	1.36	1.22	N/A
	6m	11.2	0.98	0.94	1.26	1.30	1.37	1.26	1.32	1.30	1.21
	3m	9.9	N/A	1.07	1.32	1.38	1.40	1.32	1.32	1.25	1.27
1340	Dnn	251.	254.	254.	254.	250.	250.	253.	255.	251.	N/A
	10m	10.9	1.01	1.09	1.34	1.38	1.46	1.39	1.43	1.35	N/A
	6m	11.2	1.03	0.98	1.32	1.39	1.45	1.33	1.39	1.42	1.27
	3m	9.8	N/A	1.14	1.40	1.50	1.50	1.40	1.40	1.36	1.33
1355	Dnn	250.	251.	251.	252.	246.	248.	251.	253.	248.	N/A
	10m	11.0	0.98	1.05	1.29	1.32	1.41	1.35	1.37	1.24	N/A
	6m	11.3	1.01	0.94	1.27	1.35	1.40	1.29	1.34	1.37	1.22
	3m	9.9	N/A	1.09	1.35	1.46	1.44	1.35	1.35	1.32	1.28
1410	Dnn	255.	254.	255.	255.	248.	249.	252.	254.	250.	N/A
	10m	11.2	0.90	1.04	1.23	1.18	1.30	1.28	1.33	1.21	N/A
	6m	11.5	0.94	0.92	1.22	1.24	1.29	1.23	1.30	1.33	1.18
	3m	10.0	N/A	1.08	1.31	1.35	1.34	1.29	1.31	1.30	1.24
1425	Dnn	256.	259.	258.	258.	253.	254.	257.	259.	254.	N/A
	10m	11.2	0.93	1.05	1.25	1.20	1.30	1.26	1.29	1.14	N/A
	6m	11.5	0.95	0.92	1.23	1.26	1.28	1.22	1.26	1.27	1.14
	3m	10.1	N/A	1.10	1.31	1.38	1.33	1.29	1.27	1.24	1.21
1440	Dnn	255.	257.	256.	255.	249.	251.	255.	257.	254.	N/A
	10m	11.7	0.89	1.03	1.20	1.19	1.31	1.31	1.34	1.17	N/A
	6m	11.9	0.93	0.86	1.20	1.28	1.31	1.27	1.32	1.28	1.18
	3m	10.4	N/A	1.08	1.28	1.40	1.35	1.33	1.34	1.25	1.26
1455	Dnn	260.	261.	261.	259.	253.	255.	258.	259.	255.	N/A
	10m	11.0	0.97	1.08	1.26	1.21	1.36	1.34	1.38	1.25	N/A
	6m	11.3	0.98	0.89	1.25	1.28	1.34	1.30	1.34	1.36	1.25
	3m	10.1	N/A	1.08	1.31	1.38	1.36	1.34	1.35	1.30	1.31
1510	Dnn	255.	256.	255.	255.	250.	252.	255.	257.	253.	N/A
	10m	12.1	0.93	1.00	1.21	1.18	1.28	1.24	1.28	1.14	N/A
	6m	12.4	0.94	0.82	1.19	1.23	1.27	1.21	1.25	1.24	1.12
	3m	10.9	N/A	1.02	1.26	1.34	1.30	1.26	1.26	1.20	1.17
1525	Dnn	256.	254.	254.	253.	248.	249.	252.	254.	249.	N/A
	10m	12.3	0.88	1.00	1.22	1.26	1.34	1.31	1.32	1.20	N/A
	6m	12.4	0.92	0.83	1.22	1.30	1.35	1.30	1.31	1.32	1.21
	3m	10.7	N/A	1.05	1.32	1.44	1.41	1.37	1.34	1.31	1.29

Table B.2b (cont'd.)

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MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR10
1540	Drn	253.	251.	253.	253.	247.	249.	253.	254.	250.	N/A
	10m	12.6	0.96	1.05	1.29	1.28	1.37	1.34	1.39	1.26	N/A
	6m	12.9	0.98	0.91	1.27	1.31	1.37	1.30	1.35	1.33	1.19
	3m	11.4	N/A	1.07	1.33	1.43	1.38	1.32	1.33	1.26	1.25
1555	Drn	255.	254.	254.	254.	247.	249.	252.	254.	250.	N/A
	10m	13.3	0.94	1.02	1.25	1.22	1.32	1.31	1.32	1.26	N/A
	6m	13.4	0.96	0.92	1.24	1.29	1.33	1.29	1.30	1.35	1.19
	3m	11.8	N/A	1.06	1.31	1.39	1.37	1.32	1.29	1.29	1.24
1610	Drn	257.	258.	257.	256.	250.	252.	254.	256.	253.	N/A
	10m	13.9	0.87	1.01	1.17	1.14	1.22	1.19	1.22	1.15	N/A
	6m	14.0	0.90	0.92	1.18	1.20	1.24	1.18	1.21	1.24	1.12
	3m	12.2	N/A	1.06	1.24	1.29	1.25	1.22	1.21	1.19	1.18
1625	Drn	256.	259.	258.	257.	251.	254.	257.	258.	255.	N/A
	10m	12.4	0.90	1.03	1.24	1.26	1.30	1.27	1.26	1.13	N/A
	6m	12.6	0.92	0.92	1.24	1.31	1.30	1.25	1.24	1.24	1.15
	3m	11.2	N/A	1.06	1.29	1.39	1.32	1.27	1.23	1.18	1.20
1640	Drn	261.	262.	262.	260.	254.	255.	258.	260.	257.	N/A
	10m	10.9	1.00	1.08	1.29	1.35	1.39	1.40	1.45	1.32	N/A
	6m	11.0	1.01	0.98	1.28	1.41	1.39	1.38	1.43	1.43	1.33
	3m	9.6	N/A	1.12	1.37	1.53	1.43	1.43	1.45	1.38	1.40

Table B.3a Average wind directions and speeds for 10m towers on 19/02/81. The averaging interval is 15 min. The sensors were sampled at 0.5s intervals. All speeds are in m s^{-1} .

19/ 2/81

MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR 10
1250	Dnn	271.	274.	272.	N/A	261.	258.	262.	267.	265.	264.
	10m	14.5	16.4	15.5	N/A	16.9	17.7	16.7	16.3	14.9	15.7
	6m	14.4	14.1	14.0	N/A	17.4	18.2	16.0	15.9	15.1	13.4
	3m	12.8	N/A	14.2	N/A	15.1	16.3	15.2	14.0	12.9	12.5
1305	Dnn	260.	262.	261.	N/A	255.	255.	260.	262.	259.	248.
	10m	13.7	15.5	14.2	N/A	17.0	18.3	18.1	18.5	17.7	15.0
	6m	13.7	13.4	12.2	N/A	17.6	18.8	17.3	18.2	18.4	13.1
	3m	12.1	N/A	13.0	N/A	15.6	16.8	16.3	15.9	15.5	12.3
1320	Dnn	248.	251.	248.	N/A	243.	243.	247.	249.	246.	240.
	10m	9.1	11.3	9.9	N/A	12.4	13.6	12.9	13.4	13.0	11.6
	6m	9.2	8.8	8.5	N/A	13.0	13.9	12.4	13.4	13.6	10.5
	3m	7.9	N/A	9.2	N/A	11.9	12.5	11.6	11.7	11.5	9.6
1335	Dnn	234.	237.	234.	N/A	233.	233.	236.	238.	236.	229.
	10m	7.4	9.6	8.3	N/A	10.6	11.6	10.8	10.8	10.9	11.0
	6m	7.7	7.3	7.0	N/A	11.3	12.0	10.5	10.8	11.7	9.6
	3m	6.6	N/A	7.6	N/A	10.9	11.0	10.1	9.6	10.1	8.8
1350	Dnn	223.	222.	220.	N/A	219.	219.	222.	224.	222.	219.
	10m	8.2	9.8	9.4	N/A	12.0	13.3	12.0	12.4	11.6	11.6
	6m	8.5	8.5	8.0	N/A	13.1	13.7	11.8	12.5	12.7	10.3
	3m	7.3	N/A	8.9	N/A	12.4	12.6	11.4	11.1	11.2	9.3
1405	Dnn	224.	223.	221.	N/A	220.	219.	223.	225.	223.	219.
	10m	8.5	9.8	9.1	N/A	11.2	12.5	11.9	12.2	11.5	11.9
	6m	8.8	8.2	8.0	N/A	12.2	12.9	11.6	12.3	12.5	10.6
	3m	7.5	N/A	8.3	N/A	11.6	11.7	11.1	10.9	11.0	9.5
1420	Dnn	224.	221.	220.	N/A	220.	219.	223.	224.	222.	221.
	10m	9.6	11.0	11.4	N/A	13.7	15.3	14.2	14.7	13.7	13.7
	6m	9.8	9.7	10.3	N/A	15.1	15.8	14.0	14.9	15.2	12.2
	3m	8.4	N/A	10.5	N/A	14.0	14.4	13.4	13.0	13.5	11.0
1435	Dnn	227.	227.	224.	N/A	224.	223.	226.	228.	226.	225.
	10m	8.6	10.2	10.1	N/A	12.3	13.8	12.6	13.1	12.4	11.8
	6m	8.8	8.5	9.4	N/A	13.3	14.2	12.3	13.3	13.8	10.5
	3m	7.4	N/A	9.4	N/A	12.5	13.0	11.8	11.7	12.1	9.5
1450	Dnn	226.	226.	225.	N/A	225.	224.	227.	229.	227.	223.
	10m	8.6	10.4	9.9	N/A	12.0	13.1	12.7	12.9	12.4	12.4
	6m	8.9	8.4	9.0	N/A	13.2	13.5	12.6	13.0	13.6	11.1
	3m	7.7	N/A	9.0	N/A	12.5	12.3	11.9	11.4	12.0	10.0
1505	Dnn	213.	209.	210.	N/A	211.	209.	213.	214.	212.	210.
	10m	9.5	11.3	10.9	N/A	13.2	14.8	14.0	14.0	13.1	12.9
	6m	9.8	9.5	9.7	N/A	14.6	15.3	14.2	14.3	14.8	11.0
	3m	8.4	N/A	10.1	N/A	13.8	14.2	13.4	12.6	13.2	10.0
1520	Dnn	215.	210.	211.	N/A	211.	209.	212.	213.	212.	210.
	10m	7.6	10.2	9.2	N/A	11.5	12.6	12.0	12.0	11.7	12.1
	6m	7.9	7.8	8.5	N/A	12.7	13.1	12.1	12.2	13.2	10.7
	3m	6.8	N/A	8.6	N/A	12.1	12.1	11.7	10.8	11.9	9.6

Table B.3a (cont'd.)

19/ 2/81

MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR 10
1535	Drn	210.	208.	210.	N/A	211.	210.	214.	215.	213.	212.
	10m	9.9	11.7	11.1	N/A	13.8	15.3	14.6	14.8	13.4	13.5
	6m	10.2	9.6	10.1	N/A	15.1	15.8	14.7	15.1	15.3	11.9
	3m	8.8	N/A	10.2	N/A	14.3	14.5	14.0	13.4	13.7	10.8
1550	Drn	218.	212.	214.	N/A	214.	213.	216.	218.	217.	215.
	10m	8.8	11.0	10.3	N/A	12.4	13.9	13.6	13.8	13.1	12.0
	6m	9.2	9.0	9.5	N/A	13.7	14.4	13.8	14.1	14.8	10.5
	3m	7.9	N/A	9.5	N/A	13.2	13.3	13.1	12.6	13.1	9.5
1605	Drn	224.	216.	218.	N/A	218.	217.	221.	222.	221.	217.
	10m	7.3	9.9	9.1	N/A	10.8	12.1	11.8	11.9	11.3	11.3
	6m	7.5	7.4	8.5	N/A	12.2	12.5	11.9	12.0	12.4	10.0
	3m	6.3	N/A	8.5	N/A	11.8	11.4	11.1	10.6	11.1	9.0
1620	Drn	221.	215.	216.	N/A	217.	215.	218.	219.	217.	219.
	10m	8.0	10.7	10.2	N/A	12.2	13.7	12.8	12.9	12.6	12.1
	6m	8.2	8.5	9.2	N/A	13.5	14.1	12.8	13.1	14.1	10.8
	3m	6.9	N/A	9.5	N/A	13.0	12.9	12.1	11.5	12.5	9.8
1635	Drn	232.	232.	229.	N/A	228.	226.	230.	232.	229.	229.
	10m	7.9	10.1	9.5	N/A	11.7	12.9	12.3	12.7	12.1	11.2
	6m	8.0	7.6	8.4	N/A	12.9	13.1	12.2	12.7	13.2	9.9
	3m	6.8	N/A	8.6	N/A	12.5	11.9	11.4	11.2	11.5	9.0
1650	Drn	237.	235.	229.	N/A	228.	227.	230.	231.	230.	229.
	10m	7.1	9.8	8.6	N/A	11.3	12.6	12.1	12.4	11.9	12.0
	6m	7.2	6.6	7.5	N/A	12.4	12.9	12.0	12.4	13.1	10.8
	3m	6.0	N/A	7.7	N/A	12.2	11.7	11.2	11.0	11.3	9.8

Table B.3b Same as B.3a for tower 1. For all other towers speed-up is shown in place of speed.

19/ 2/81

MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR10
1250	Drn	271.	274.	272.	N/A	261.	258.	262.	267.	265.	264.
	10m	14.5	1.13	1.07	N/A	1.16	1.22	1.15	1.12	1.03	1.08
	6m	14.4	0.97	0.97	N/A	1.20	1.26	1.11	1.10	1.04	0.93
	3m	12.8	N/A	1.11	N/A	1.18	1.28	1.19	1.10	1.01	0.98
1305	Drn	260.	262.	261.	N/A	255.	255.	260.	262.	259.	248.
	10m	13.7	1.13	1.04	N/A	1.24	1.33	1.32	1.35	1.29	1.10
	6m	13.7	0.97	0.89	N/A	1.28	1.37	1.26	1.33	1.34	0.96
	3m	12.1	N/A	1.08	N/A	1.29	1.39	1.35	1.32	1.28	1.02
1320	Drn	248.	251.	248.	N/A	243.	243.	247.	249.	246.	240.
	10m	9.1	1.23	1.08	N/A	1.36	1.49	1.41	1.47	1.43	1.26
	6m	9.2	0.95	0.92	N/A	1.40	1.50	1.35	1.45	1.47	1.13
	3m	7.9	N/A	1.16	N/A	1.50	1.58	1.47	1.48	1.45	1.21
1335	Drn	234.	237.	234.	N/A	233.	233.	236.	238.	236.	229.
	10m	7.4	1.30	1.12	N/A	1.43	1.56	1.46	1.46	1.47	1.49
	6m	7.7	0.95	0.91	N/A	1.48	1.56	1.37	1.41	1.53	1.25
	3m	6.6	N/A	1.16	N/A	1.65	1.66	1.53	1.45	1.53	1.34
1350	Drn	223.	222.	220.	N/A	219.	219.	222.	224.	222.	219.
	10m	8.2	1.19	1.15	N/A	1.46	1.62	1.47	1.51	1.41	1.41
	6m	8.5	1.00	0.94	N/A	1.54	1.61	1.39	1.47	1.49	1.21
	3m	7.3	N/A	1.21	N/A	1.69	1.72	1.55	1.52	1.53	1.27
1405	Drn	224.	223.	221.	N/A	220.	219.	223.	225.	223.	219.
	10m	8.5	1.15	1.07	N/A	1.31	1.47	1.40	1.43	1.35	1.39
	6m	8.8	0.93	0.91	N/A	1.39	1.47	1.32	1.40	1.42	1.21
	3m	7.5	N/A	1.11	N/A	1.55	1.56	1.47	1.45	1.47	1.27
1420	Drn	224.	221.	220.	N/A	220.	219.	223.	224.	222.	221.
	10m	9.6	1.15	1.19	N/A	1.44	1.60	1.49	1.54	1.43	1.43
	6m	9.8	0.99	1.05	N/A	1.54	1.62	1.43	1.52	1.56	1.25
	3m	8.4	N/A	1.24	N/A	1.67	1.71	1.59	1.55	1.61	1.31
1435	Drn	227.	227.	224.	N/A	224.	223.	226.	228.	226.	225.
	10m	8.6	1.19	1.17	N/A	1.42	1.60	1.46	1.52	1.44	1.37
	6m	8.8	0.96	1.07	N/A	1.52	1.62	1.41	1.51	1.57	1.20
	3m	7.4	N/A	1.26	N/A	1.68	1.75	1.59	1.58	1.63	1.28
1450	Drn	226.	226.	225.	N/A	225.	224.	227.	229.	227.	223.
	10m	8.6	1.20	1.14	N/A	1.39	1.53	1.47	1.50	1.44	1.44
	6m	8.9	0.94	1.01	N/A	1.48	1.51	1.42	1.46	1.53	1.25
	3m	7.7	N/A	1.18	N/A	1.64	1.61	1.55	1.49	1.57	1.31
1505	Drn	213.	209.	210.	N/A	211.	209.	213.	214.	212.	210.
	10m	9.5	1.19	1.15	N/A	1.39	1.56	1.47	1.48	1.39	1.35
	6m	9.8	0.97	0.99	N/A	1.49	1.56	1.45	1.46	1.51	1.13
	3m	8.4	N/A	1.20	N/A	1.64	1.68	1.59	1.50	1.57	1.19
1520	Drn	215.	210.	211.	N/A	211.	209.	212.	213.	212.	210.
	10m	7.6	1.34	1.21	N/A	1.52	1.66	1.58	1.58	1.54	1.60
	6m	7.9	0.99	1.06	N/A	1.60	1.64	1.53	1.54	1.66	1.35
	3m	6.8	N/A	1.27	N/A	1.78	1.77	1.72	1.59	1.74	1.41

Table B.3b (cont'd.)

19/ 2/81

MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR10
1535	Drn	210.	208.	210.	N/A	211.	210.	214.	215.	213.	212.
	10m	9.9	1.18	1.12	N/A	1.39	1.54	1.47	1.49	1.36	1.36
	6m	10.2	0.94	0.99	N/A	1.47	1.55	1.43	1.48	1.50	1.16
	3m	8.8	N/A	1.16	N/A	1.62	1.65	1.59	1.52	1.56	1.23
1550	Drn	218.	212.	214.	N/A	214.	213.	216.	218.	217.	215.
	10m	8.8	1.25	1.17	N/A	1.41	1.58	1.55	1.57	1.49	1.36
	6m	9.2	0.98	1.03	N/A	1.50	1.58	1.51	1.54	1.61	1.15
	3m	7.9	N/A	1.21	N/A	1.68	1.69	1.67	1.60	1.67	1.21
1605	Drn	224.	216.	218.	N/A	218.	217.	221.	222.	221.	217.
	10m	7.3	1.34	1.25	N/A	1.47	1.65	1.61	1.62	1.53	1.54
	6m	7.5	0.98	1.12	N/A	1.62	1.66	1.58	1.59	1.65	1.32
	3m	6.3	N/A	1.35	N/A	1.88	1.81	1.76	1.69	1.76	1.43
1620	Drn	221.	215.	216.	N/A	217.	215.	218.	219.	217.	219.
	10m	8.0	1.34	1.28	N/A	1.53	1.72	1.60	1.62	1.58	1.51
	6m	8.2	1.04	1.12	N/A	1.64	1.72	1.56	1.59	1.72	1.31
	3m	6.9	N/A	1.37	N/A	1.88	1.87	1.76	1.66	1.81	1.42
1635	Drn	232.	232.	229.	N/A	228.	226.	230.	232.	229.	229.
	10m	7.9	1.28	1.21	N/A	1.49	1.65	1.57	1.62	1.53	1.43
	6m	8.0	0.95	1.05	N/A	1.61	1.64	1.53	1.59	1.66	1.24
	3m	6.8	N/A	1.27	N/A	1.84	1.75	1.69	1.65	1.70	1.33
1650	Drn	237.	235.	229.	N/A	228.	227.	230.	231.	230.	229.
	10m	7.1	1.38	1.22	N/A	1.60	1.79	1.71	1.76	1.69	1.70
	6m	7.2	0.91	1.05	N/A	1.73	1.79	1.67	1.73	1.82	1.51
	3m	6.0	N/A	1.28	N/A	2.03	1.94	1.86	1.82	1.88	1.64

Table B.4a Average wind directions and speeds for 10m towers on 20/02/81. The averaging interval is 15 min. The sensors were sampled at 0.5s intervals. All speeds are in m s^{-1} .

20/ 2/81

MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR10
1030	Drn	264.	267.	267.	266.	262.	260.	264.	265.	264.	265.
	10m	12.3	14.1	12.9	15.2	14.5	15.2	14.4	14.9	13.5	14.2
	6m	12.4	11.4	11.8	15.4	15.1	15.6	13.9	14.7	14.5	14.7
	3m	10.8	N/A	12.0	14.4	13.9	13.8	12.8	13.1	12.1	13.8
1045	Drn	263.	267.	267.	267.	262.	261.	265.	266.	264.	267.
	10m	11.8	15.8	12.8	14.9	14.3	15.3	15.2	15.3	14.1	13.9
	6m	12.2	12.0	11.8	15.0	15.1	15.8	14.9	15.1	14.9	14.3
	3m	10.7	N/A	11.8	13.9	13.7	14.1	13.6	13.5	12.6	13.3
1100	Drn	264.	268.	268.	267.	262.	261.	264.	265.	262.	265.
	10m	11.9	15.6	12.4	14.4	14.0	15.0	14.6	14.6	13.4	13.2
	6m	12.2	11.4	11.7	14.6	14.7	15.3	14.2	14.4	14.2	13.7
	3m	10.6	N/A	11.5	13.6	13.5	13.7	13.2	12.8	11.9	12.7
1115	Drn	261.	265.	263.	265.	260.	258.	262.	263.	260.	263.
	10m	11.7	15.4	12.4	14.3	13.8	14.8	14.6	14.6	13.7	13.4
	6m	11.9	11.2	11.8	14.7	14.7	15.1	14.3	14.5	14.5	13.8
	3m	10.4	N/A	11.4	13.7	13.5	13.4	13.2	12.9	12.3	12.8
1130	Drn	260.	266.	264.	264.	260.	258.	261.	262.	259.	262.
	10m	12.6	15.6	12.5	14.6	13.9	14.9	14.8	15.1	14.5	13.8
	6m	12.9	11.4	11.9	14.9	14.8	15.2	14.7	15.0	15.4	14.2
	3m	11.3	N/A	11.6	13.9	13.9	13.6	13.6	13.4	13.0	13.2
1145	Drn	261.	265.	264.	265.	259.	257.	261.	262.	259.	264.
	10m	13.0	16.2	13.4	15.1	15.0	15.9	15.5	15.8	14.7	13.9
	6m	13.2	12.2	12.4	15.4	15.8	16.3	15.3	15.7	15.6	14.4
	3m	11.7	N/A	12.5	14.4	14.8	14.7	14.1	14.0	13.2	13.4
1200	Drn	258.	261.	260.	261.	255.	253.	255.	256.	254.	258.
	10m	12.7	16.0	13.1	14.7	14.3	15.5	15.3	15.9	15.3	14.2
	6m	12.9	12.1	11.6	15.1	15.4	15.8	15.0	15.9	16.0	14.7
	3m	11.3	N/A	12.2	14.1	14.5	14.2	13.6	14.1	13.5	13.6
1215	Drn	255.	259.	258.	259.	254.	253.	256.	258.	255.	259.
	10m	12.7	16.3	13.3	15.7	15.7	16.8	16.6	17.1	15.8	15.1
	6m	12.9	12.6	11.5	16.0	16.8	17.2	16.5	17.0	16.8	15.5
	3m	11.3	N/A	12.1	15.0	15.8	15.6	15.1	15.1	14.2	14.3
1230	Drn	255.	259.	258.	260.	255.	253.	257.	258.	256.	260.
	10m	13.6	16.4	14.4	16.2	16.3	17.0	16.8	17.4	16.5	15.4
	6m	13.8	12.9	13.6	16.5	17.4	17.4	16.8	17.4	17.4	15.9
	3m	12.1	N/A	13.2	15.4	16.3	15.7	15.3	15.5	14.7	14.7
1245	Drn	258.	260.	258.	260.	255.	255.	258.	259.	256.	260.
	10m	12.6	16.3	14.3	16.4	15.9	16.7	16.8	16.8	15.7	14.8
	6m	12.7	12.8	13.8	16.7	17.0	17.1	16.8	16.7	16.7	15.3
	3m	11.2	N/A	13.2	15.6	16.0	15.5	15.3	14.8	14.2	14.2
1300	Drn	261.	263.	260.	261.	257.	256.	259.	260.	257.	261.
	10m	13.2	16.3	13.6	16.2	15.7	16.5	16.3	16.6	15.6	15.0
	6m	13.5	12.7	12.6	16.5	16.6	16.9	16.4	16.5	16.6	15.7
	3m	11.9	N/A	12.5	15.4	15.8	15.2	14.9	14.7	14.1	14.7

Table B.4a (cont'd.)

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MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR 10
1315	Dnn	258.	262.	260.	261.	255.	254.	258.	260.	257.	261.
	10m	13.7	16.3	14.1	16.3	16.0	17.0	16.9	17.6	16.5	15.5
	6m	14.0	12.8	12.6	16.7	17.1	17.5	16.9	17.5	17.5	16.0
	3m	12.3	N/A	12.9	15.5	16.2	15.7	15.2	15.6	14.8	14.9
1330	Dnn	261.	264.	262.	263.	259.	258.	261.	263.	260.	264.
	10m	13.7	16.6	14.4	16.6	16.4	17.0	17.1	17.4	16.2	15.7
	6m	14.0	13.1	12.7	16.9	17.3	17.4	17.1	17.3	17.1	16.1
	3m	12.3	N/A	13.2	15.7	16.3	15.7	15.5	15.4	14.5	14.9
1345	Dnn	260.	263.	263.	264.	259.	257.	261.	262.	260.	262.
	10m	13.9	16.9	14.8	16.6	16.2	17.0	16.9	17.3	16.2	15.3
	6m	14.1	13.2	13.3	16.9	17.1	17.5	16.9	17.3	17.1	15.7
	3m	12.5	N/A	13.6	15.6	16.1	15.7	15.3	15.5	14.5	14.7
1400	Dnn	261.	265.	264.	265.	261.	260.	262.	263.	260.	264.
	10m	13.8	17.0	14.6	16.9	16.3	16.7	16.5	16.8	15.7	15.1
	6m	13.9	13.4	13.7	17.1	17.3	17.1	16.6	16.8	16.8	15.6
	3m	12.2	N/A	13.5	15.9	16.3	15.4	14.9	15.0	14.2	14.5
1415	Dnn	261.	265.	265.	265.	261.	260.	263.	265.	262.	266.
	10m	13.5	16.7	14.1	16.5	15.9	16.5	16.5	16.9	15.7	15.1
	6m	13.7	13.0	13.3	16.7	16.7	16.9	16.7	16.9	16.6	15.6
	3m	12.1	N/A	13.1	15.6	15.8	15.2	15.1	15.1	14.0	14.5
1430	Dnn	257.	261.	258.	260.	255.	255.	258.	259.	257.	261.
	10m	13.2	16.3	14.1	16.2	15.9	16.8	16.7	16.9	15.9	15.0
	6m	13.3	12.6	13.3	16.6	16.9	17.2	16.9	16.9	16.9	15.6
	3m	11.6	N/A	12.9	15.4	16.2	15.4	15.1	15.1	14.2	14.4
1445	Dnn	257.	260.	258.	259.	254.	253.	257.	258.	255.	261.
	10m	13.2	16.3	13.8	15.8	15.9	16.9	16.6	16.7	15.4	14.6
	6m	13.5	12.7	13.1	16.1	17.1	17.3	16.8	16.6	16.3	15.2
	3m	11.7	N/A	12.9	14.9	16.3	15.5	15.1	14.9	13.9	14.1
1500	Dnn	259.	262.	259.	259.	255.	254.	257.	258.	255.	260.
	10m	13.0	15.9	13.1	15.6	15.0	16.1	15.9	16.3	15.5	14.2
	6m	13.2	12.3	12.5	15.9	16.1	16.5	16.2	16.2	16.6	14.8
	3m	11.6	N/A	12.1	14.9	15.4	14.9	14.4	14.4	14.0	13.7

Table B.4b Same as B.4a for tower 1. For all other towers speed-up is shown in place of speed.

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MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR10
1030	Drn	264.	267.	267.	266.	262.	260.	264.	265.	264.	265.
	10m	12.3	1.14	1.04	1.23	1.17	1.23	1.17	1.20	1.09	1.15
	6m	12.4	0.92	0.95	1.24	1.22	1.26	1.12	1.18	1.17	1.18
	3m	10.8	N/A	1.11	1.33	1.28	1.28	1.18	1.21	1.11	1.27
1045	Drn	263.	267.	267.	267.	262.	261.	265.	266.	264.	267.
	10m	11.8	1.33	1.08	1.26	1.21	1.29	1.28	1.29	1.19	1.17
	6m	12.2	0.99	0.97	1.23	1.24	1.30	1.22	1.24	1.23	1.18
	3m	10.7	N/A	1.10	1.31	1.29	1.33	1.28	1.27	1.18	1.24
1100	Drn	264.	268.	268.	267.	262.	261.	264.	265.	262.	265.
	10m	11.9	1.31	1.04	1.21	1.17	1.26	1.22	1.22	1.12	1.11
	6m	12.2	0.94	0.96	1.20	1.21	1.26	1.17	1.18	1.16	1.12
	3m	10.6	N/A	1.09	1.28	1.27	1.30	1.24	1.21	1.13	1.20
1115	Drn	261.	265.	263.	265.	260.	258.	262.	263.	260.	263.
	10m	11.7	1.32	1.06	1.23	1.18	1.27	1.25	1.26	1.17	1.14
	6m	11.9	0.94	0.99	1.23	1.24	1.27	1.20	1.22	1.22	1.16
	3m	10.4	N/A	1.09	1.31	1.29	1.29	1.27	1.24	1.18	1.23
1130	Drn	260.	266.	264.	264.	260.	258.	261.	262.	259.	262.
	10m	12.6	1.24	0.99	1.16	1.11	1.18	1.18	1.20	1.15	1.09
	6m	12.9	0.88	0.92	1.16	1.15	1.18	1.14	1.16	1.19	1.10
	3m	11.3	N/A	1.02	1.22	1.22	1.20	1.20	1.18	1.14	1.16
1145	Drn	261.	265.	264.	265.	259.	257.	261.	262.	259.	264.
	10m	13.0	1.24	1.03	1.16	1.15	1.22	1.19	1.21	1.13	1.07
	6m	13.2	0.92	0.94	1.17	1.19	1.23	1.16	1.19	1.18	1.09
	3m	11.7	N/A	1.07	1.23	1.27	1.26	1.21	1.20	1.13	1.15
1200	Drn	258.	261.	260.	261.	255.	253.	255.	256.	254.	258.
	10m	12.7	1.26	1.03	1.16	1.13	1.22	1.20	1.25	1.20	1.12
	6m	12.9	0.94	0.90	1.17	1.19	1.22	1.16	1.23	1.24	1.14
	3m	11.3	N/A	1.08	1.24	1.28	1.25	1.20	1.24	1.20	1.20
1215	Drn	255.	259.	258.	259.	254.	253.	256.	258.	255.	259.
	10m	12.7	1.28	1.04	1.24	1.24	1.32	1.31	1.35	1.24	1.19
	6m	12.9	0.98	0.89	1.24	1.30	1.34	1.28	1.32	1.30	1.20
	3m	11.3	N/A	1.07	1.33	1.40	1.38	1.34	1.34	1.26	1.27
1230	Drn	255.	259.	258.	260.	255.	253.	257.	258.	256.	260.
	10m	13.6	1.20	1.05	1.19	1.19	1.25	1.23	1.28	1.21	1.13
	6m	13.8	0.93	0.99	1.20	1.26	1.27	1.22	1.26	1.26	1.15
	3m	12.1	N/A	1.09	1.28	1.35	1.30	1.26	1.28	1.22	1.22
1245	Drn	258.	260.	258.	260.	255.	255.	258.	259.	256.	260.
	10m	12.6	1.30	1.13	1.30	1.26	1.33	1.33	1.33	1.25	1.17
	6m	12.7	1.01	1.08	1.31	1.34	1.35	1.32	1.31	1.31	1.20
	3m	11.2	N/A	1.18	1.39	1.43	1.38	1.37	1.32	1.27	1.27
1300	Drn	261.	263.	260.	261.	257.	256.	259.	260.	257.	261.
	10m	13.2	1.23	1.03	1.22	1.19	1.25	1.24	1.25	1.18	1.13
	6m	13.5	0.94	0.93	1.22	1.23	1.25	1.22	1.22	1.23	1.16
	3m	11.9	N/A	1.05	1.29	1.33	1.28	1.25	1.24	1.18	1.23

Table B.4b (cont'd.)

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MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR 10
1315	Drn	258.	262.	260.	261.	255.	254.	258.	260.	257.	261.
	10m	13.7	1.19	1.03	1.19	1.17	1.24	1.23	1.29	1.21	1.14
	6m	14.0	0.91	0.91	1.19	1.22	1.25	1.21	1.25	1.26	1.15
	3m	12.3	N/A	1.05	1.27	1.32	1.28	1.24	1.27	1.21	1.21
1330	Drn	261.	264.	262.	263.	259.	258.	261.	263.	260.	264.
	10m	13.7	1.21	1.05	1.21	1.20	1.24	1.25	1.27	1.18	1.14
	6m	14.0	0.94	0.91	1.21	1.24	1.25	1.22	1.24	1.22	1.15
	3m	12.3	N/A	1.07	1.28	1.33	1.28	1.26	1.26	1.18	1.21
1345	Drn	260.	263.	263.	264.	259.	257.	261.	262.	260.	262.
	10m	13.9	1.22	1.07	1.20	1.17	1.22	1.22	1.25	1.17	1.10
	6m	14.1	0.94	0.94	1.20	1.21	1.24	1.20	1.23	1.22	1.12
	3m	12.5	N/A	1.09	1.25	1.29	1.25	1.22	1.24	1.16	1.17
1400	Drn	261.	265.	264.	265.	261.	260.	262.	263.	260.	264.
	10m	13.8	1.23	1.06	1.22	1.19	1.21	1.20	1.22	1.14	1.10
	6m	13.9	0.96	0.99	1.23	1.24	1.23	1.19	1.21	1.21	1.12
	3m	12.2	N/A	1.10	1.30	1.33	1.26	1.22	1.23	1.16	1.19
1415	Drn	261.	265.	265.	265.	261.	260.	263.	265.	262.	266.
	10m	13.5	1.24	1.05	1.22	1.18	1.23	1.23	1.26	1.17	1.12
	6m	13.7	0.95	0.97	1.22	1.22	1.24	1.22	1.23	1.21	1.14
	3m	12.1	N/A	1.08	1.28	1.30	1.25	1.25	1.25	1.16	1.20
1430	Drn	257.	261.	258.	260.	255.	255.	258.	259.	257.	261.
	10m	13.2	1.24	1.07	1.23	1.21	1.27	1.27	1.28	1.21	1.14
	6m	13.3	0.95	1.00	1.24	1.27	1.29	1.27	1.27	1.27	1.17
	3m	11.6	N/A	1.12	1.33	1.39	1.33	1.30	1.30	1.23	1.25
1445	Drn	257.	260.	258.	259.	254.	253.	257.	258.	255.	261.
	10m	13.2	1.23	1.04	1.19	1.20	1.27	1.26	1.26	1.16	1.11
	6m	13.5	0.95	0.98	1.19	1.27	1.29	1.25	1.23	1.21	1.13
	3m	11.7	N/A	1.10	1.27	1.39	1.32	1.29	1.27	1.18	1.20
1500	Drn	259.	262.	259.	259.	255.	254.	257.	258.	255.	260.
	10m	13.0	1.23	1.01	1.20	1.16	1.24	1.22	1.25	1.19	1.09
	6m	13.2	0.93	0.94	1.20	1.21	1.25	1.22	1.23	1.25	1.12
	3m	11.6	N/A	1.04	1.28	1.32	1.28	1.24	1.24	1.21	1.18

Table B.5a Average wind directions and speeds for 10m towers on 21/02/81. The averaging interval is 15 min. The sensors were sampled at 0.25s intervals. All speeds are in m s^{-1} .

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MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR10
1300	Drrn	260.	265.	264.	265.	262.	260.	264.	266.	262.	N/A
	10m	13.8	13.4	14.1	16.6	16.2	16.9	16.4	15.8	15.1	N/A
	6m	14.0	13.3	13.5	16.8	16.9	17.4	17.3	15.5	15.8	15.6
	3m	12.4	N/A	13.0	15.7	15.4	15.5	15.0	13.8	13.1	14.6
1315	Drrn	260.	263.	263.	266.	261.	260.	263.	265.	262.	N/A
	10m	13.1	13.4	14.4	16.9	16.3	17.1	16.5	17.0	15.8	N/A
	6m	13.3	13.2	13.9	17.2	17.0	17.7	17.5	16.8	16.5	15.3
	3m	11.8	N/A	13.3	16.0	15.6	15.7	15.0	15.1	14.1	14.2
1330	Drrn	262.	265.	264.	266.	260.	259.	263.	265.	262.	N/A
	10m	14.0	13.6	14.2	16.6	16.2	17.0	16.4	17.2	16.0	N/A
	6m	14.2	13.6	13.7	16.9	17.1	17.6	17.5	16.9	16.7	15.8
	3m	12.4	N/A	13.2	15.8	15.9	15.8	15.0	15.1	14.1	14.8
1345	Drrn	263.	267.	264.	266.	260.	258.	261.	263.	261.	N/A
	10m	12.2	12.2	13.2	15.3	15.0	16.1	15.8	16.5	15.7	N/A
	6m	12.5	12.2	12.6	15.7	15.8	16.7	16.8	16.2	16.4	15.2
	3m	11.1	N/A	12.3	14.7	14.9	15.0	14.4	14.5	13.9	14.0
1400	Drrn	259.	264.	263.	265.	259.	258.	262.	264.	262.	N/A
	10m	12.1	12.2	13.2	15.2	14.9	16.2	15.7	16.2	15.5	N/A
	6m	12.5	12.1	12.5	15.6	15.8	16.7	16.8	16.1	16.2	14.6
	3m	11.0	N/A	12.3	14.6	14.8	15.1	14.5	14.5	13.8	13.6
1415	Drrn	260.	262.	261.	265.	258.	257.	260.	262.	260.	N/A
	10m	12.4	12.2	12.9	14.7	14.4	15.3	14.7	15.4	14.5	N/A
	6m	12.6	12.2	12.3	15.2	15.1	15.7	15.7	15.2	15.3	14.0
	3m	11.0	N/A	12.1	14.1	14.3	14.1	13.6	13.7	13.0	13.0
1430	Drrn	261.	264.	264.	265.	260.	259.	263.	265.	263.	N/A
	10m	12.8	12.8	13.8	16.0	15.8	16.8	16.2	16.9	15.9	N/A
	6m	13.0	12.7	13.2	16.4	16.5	17.4	17.2	16.8	16.7	15.6
	3m	11.4	N/A	12.9	15.3	15.5	15.6	14.8	15.0	14.1	14.6
1445	Drrn	269.	274.	273.	271.	267.	268.	272.	273.	271.	N/A
	10m	13.0	13.2	14.0	16.1	15.8	16.5	16.1	16.7	15.8	N/A
	6m	13.1	13.3	13.4	16.3	16.3	17.1	17.1	16.5	16.4	15.2
	3m	11.4	N/A	13.0	15.0	15.2	15.2	14.7	14.8	13.8	14.1
1500	Drrn	269.	272.	273.	271.	267.	268.	272.	273.	271.	N/A
	10m	11.8	12.6	13.2	15.4	15.2	15.9	15.7	16.3	15.5	N/A
	6m	12.1	12.5	12.6	15.6	15.7	16.5	16.6	16.1	16.1	14.9
	3m	10.6	N/A	12.3	14.6	14.8	14.8	14.3	14.4	13.5	13.8
1515	Drrn	266.	274.	273.	271.	267.	268.	272.	273.	271.	N/A
	10m	11.8	11.6	12.4	14.5	14.4	15.2	14.9	15.4	14.6	N/A
	6m	11.9	11.6	11.9	14.7	14.9	15.6	15.7	15.1	15.0	14.3
	3m	10.4	N/A	11.6	13.6	13.9	13.9	13.4	13.6	12.6	13.2
1530	Drrn	260.	267.	269.	269.	263.	265.	268.	270.	268.	N/A
	10m	10.9	11.3	12.5	14.4	13.8	14.9	14.6	15.2	14.6	N/A
	6m	11.2	11.2	12.1	14.6	14.3	15.3	15.5	15.1	15.2	13.5
	3m	9.7	N/A	11.6	13.5	13.6	13.8	13.4	13.6	12.8	12.6

Table B.5a (cont'd.)

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MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR10
1545	Drn	259.	262.	0.	0.	257.	257.	261.	262.	260.	N/A
	10m	11.2	10.0	0.0	0.0	12.8	13.9	13.3	13.9	13.1	N/A
	6m	11.4	10.1	0.0	0.0	13.5	14.3	14.2	13.8	13.8	12.5
	3m	10.0	N/A	0.0	0.0	13.1	12.8	12.2	12.3	11.8	11.7

Table B.5b Same as B.5a for tower 1. For all other towers speed-up is shown in place of speed.

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MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR10
1300	Drn	260.	265.	264.	265.	262.	260.	264.	266.	262.	N/A
	10m	13.8	0.97	1.02	1.20	1.17	1.22	1.19	1.14	1.09	N/A
	6m	14.0	0.95	0.96	1.20	1.20	1.24	1.23	1.11	1.13	1.11
	3m	12.4	N/A	1.05	1.27	1.24	1.25	1.21	1.12	1.06	1.18
1315	Drn	260.	263.	263.	266.	261.	260.	263.	265.	262.	N/A
	10m	13.1	1.02	1.10	1.29	1.25	1.31	1.26	1.30	1.21	N/A
	6m	13.3	0.99	1.04	1.30	1.28	1.33	1.32	1.26	1.24	1.15
	3m	11.8	N/A	1.13	1.36	1.33	1.34	1.28	1.29	1.20	1.21
1330	Drn	262.	265.	264.	266.	260.	259.	263.	265.	262.	N/A
	10m	14.0	0.97	1.01	1.18	1.16	1.21	1.17	1.23	1.14	N/A
	6m	14.2	0.96	0.97	1.19	1.20	1.24	1.23	1.19	1.18	1.12
	3m	12.4	N/A	1.06	1.27	1.28	1.28	1.21	1.22	1.13	1.19
1345	Drn	263.	267.	264.	266.	260.	258.	261.	263.	261.	N/A
	10m	12.2	1.00	1.08	1.25	1.22	1.31	1.29	1.35	1.28	N/A
	6m	12.5	0.97	1.01	1.26	1.26	1.33	1.34	1.30	1.31	1.21
	3m	11.1	N/A	1.11	1.32	1.34	1.35	1.30	1.31	1.25	1.26
1400	Drn	259.	264.	263.	265.	259.	258.	262.	264.	262.	N/A
	10m	12.1	1.01	1.09	1.26	1.23	1.34	1.30	1.34	1.28	N/A
	6m	12.5	0.97	1.01	1.25	1.27	1.34	1.35	1.29	1.30	1.17
	3m	11.0	N/A	1.12	1.32	1.35	1.37	1.32	1.32	1.26	1.24
1415	Drn	260.	262.	261.	265.	258.	257.	260.	262.	260.	N/A
	10m	12.4	0.99	1.04	1.19	1.16	1.24	1.19	1.24	1.17	N/A
	6m	12.6	0.96	0.97	1.20	1.19	1.24	1.24	1.20	1.21	1.11
	3m	11.0	N/A	1.09	1.28	1.30	1.28	1.23	1.24	1.17	1.18
1430	Drn	261.	264.	264.	265.	260.	259.	263.	265.	263.	N/A
	10m	12.8	1.00	1.08	1.25	1.24	1.31	1.27	1.32	1.24	N/A
	6m	13.0	0.98	1.02	1.26	1.28	1.34	1.33	1.30	1.29	1.21
	3m	11.4	N/A	1.13	1.35	1.36	1.37	1.30	1.32	1.24	1.28
1445	Drn	269.	274.	273.	271.	267.	268.	272.	273.	271.	N/A
	10m	13.0	1.01	1.07	1.24	1.21	1.26	1.24	1.28	1.21	N/A
	6m	13.1	1.01	1.02	1.24	1.24	1.30	1.30	1.26	1.25	1.16
	3m	11.4	N/A	1.13	1.32	1.33	1.33	1.29	1.29	1.20	1.24
1500	Drn	269.	272.	273.	271.	267.	268.	272.	273.	271.	N/A
	10m	11.8	1.06	1.12	1.30	1.28	1.35	1.32	1.38	1.31	N/A
	6m	12.1	1.04	1.05	1.30	1.30	1.37	1.38	1.34	1.33	1.23
	3m	10.6	N/A	1.16	1.37	1.40	1.40	1.35	1.36	1.27	1.30
1515	Drn	266.	274.	273.	271.	267.	268.	272.	273.	271.	N/A
	10m	11.8	0.99	1.05	1.23	1.22	1.29	1.26	1.31	1.23	N/A
	6m	11.9	0.97	1.00	1.23	1.24	1.31	1.32	1.27	1.26	1.20
	3m	10.4	N/A	1.11	1.31	1.34	1.33	1.29	1.30	1.21	1.27
1530	Drn	260.	267.	269.	269.	263.	265.	268.	270.	268.	N/A
	10m	10.9	1.03	1.14	1.31	1.26	1.36	1.34	1.39	1.33	N/A
	6m	11.2	1.00	1.08	1.31	1.28	1.37	1.39	1.35	1.36	1.21
	3m	9.7	N/A	1.20	1.39	1.40	1.42	1.38	1.40	1.32	1.30

Table B.5b (cont'd.)

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MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR10
1545	Drn	259.	262.	0.	0.	257.	257.	261.	262.	260.	N/A
	10m	11.2	0.89	0.00	0.00	1.15	1.25	1.19	1.25	1.17	N/A
	6m	11.4	0.88	0.00	0.00	1.18	1.25	1.24	1.21	1.21	1.10
	3m	10.0	N/A	0.00	0.00	1.31	1.28	1.22	1.23	1.18	1.17

Table B.6a Average wind directions and speeds for 10m towers on 22/02/81. The averaging interval is 15 min. The sensors were sampled at 0.5s intervals. All speeds are in m s^{-1} .

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MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR10
1000	Drn	249.	249.	0.	253.	246.	246.	254.	251.	250.	N/A
	10m	5.5	6.7	0.0	8.7	9.4	10.2	10.7	10.4	9.8	N/A
	6m	5.7	6.5	0.0	8.9	9.8	10.4	11.1	10.2	10.2	8.9
	3m	4.6	N/A	0.0	8.2	9.0	9.4	9.7	9.0	8.6	8.2
1015	Drn	251.	257.	0.	256.	252.	251.	251.	256.	254.	N/A
	10m	6.1	5.9	0.0	7.6	7.8	8.6	9.8	8.7	8.3	N/A
	6m	6.2	5.8	0.0	7.7	8.2	8.8	10.2	8.5	8.5	7.3
	3m	5.2	N/A	0.0	7.1	8.1	7.9	8.9	7.5	7.2	6.8
1030	Drn	248.	251.	0.	253.	247.	247.	254.	252.	251.	N/A
	10m	7.6	6.4	0.0	7.7	7.8	8.4	9.0	8.6	8.1	N/A
	6m	7.7	6.2	0.0	7.9	8.2	8.6	9.4	8.4	8.4	7.2
	3m	6.5	N/A	0.0	7.3	8.1	7.7	8.2	7.4	7.0	-6.6
1045	Drn	252.	254.	0.	256.	250.	250.	251.	254.	252.	N/A
	10m	7.8	7.6	0.0	9.9	9.9	10.5	7.8	10.8	10.2	N/A
	6m	8.1	7.6	0.0	10.2	10.4	10.7	8.2	10.6	10.6	9.5
	3m	6.9	N/A	0.0	9.4	9.9	9.6	7.0	9.3	8.9	8.8
1100	Drn	248.	252.	0.	256.	251.	251.	251.	256.	253.	N/A
	10m	8.8	8.4	0.0	11.0	11.2	11.8	9.5	11.9	11.1	N/A
	6m	8.9	8.3	0.0	11.2	11.8	12.0	9.9	11.6	11.5	10.6
	3m	7.6	N/A	0.0	10.4	11.1	10.9	8.6	10.2	9.7	9.8
1115	Drn	245.	248.	0.	251.	244.	243.	255.	249.	248.	N/A
	10m	8.6	9.2	0.0	10.7	11.3	12.5	11.4	12.6	11.8	N/A
	6m	8.8	9.2	0.0	11.2	12.0	12.7	11.8	12.5	12.4	11.0
	3m	7.6	N/A	0.0	10.3	11.5	11.4	10.5	11.0	10.4	10.1
1130	Drn	248.	250.	0.	253.	244.	243.	248.	247.	246.	N/A
	10m	9.2	9.0	0.0	11.1	11.7	12.6	11.9	13.1	12.5	N/A
	6m	9.4	8.9	0.0	11.8	12.5	13.0	12.2	13.1	13.2	11.4
	3m	8.1	N/A	0.0	10.9	12.0	11.7	10.9	11.6	11.2	10.6
1145	Drn	252.	255.	0.	255.	247.	246.	246.	250.	248.	N/A
	10m	11.6	9.2	0.0	12.0	12.7	13.4	12.6	13.5	12.5	N/A
	6m	11.8	9.3	0.0	12.6	13.4	13.7	12.8	13.3	13.3	12.4
	3m	10.3	N/A	0.0	11.7	12.9	12.3	11.5	11.7	11.3	11.4
1200	Drn	257.	257.	0.	256.	248.	248.	247.	252.	249.	N/A
	10m	11.6	11.1	0.0	13.3	14.1	14.9	12.8	15.2	14.2	N/A
	6m	11.9	10.9	0.0	13.8	14.9	15.2	13.1	15.1	14.9	13.9
	3m	10.4	N/A	0.0	12.9	14.1	13.6	11.7	13.3	12.5	12.7
1215	Drn	258.	258.	0.	257.	251.	251.	250.	255.	252.	N/A
	10m	11.7	11.7	0.0	14.8	15.4	16.2	13.9	16.4	15.3	N/A
	6m	12.0	11.6	0.0	15.1	16.2	16.5	14.2	16.1	16.0	15.0
	3m	10.3	N/A	0.0	13.9	15.2	14.7	12.6	14.4	13.6	13.8
1230	Drn	260.	262.	0.	260.	253.	253.	254.	257.	254.	N/A
	10m	13.7	11.2	0.0	15.1	15.0	15.8	15.7	16.3	15.2	N/A
	6m	13.9	12.8	0.0	15.4	15.7	16.1	15.9	16.1	15.8	14.6
	3m	12.2	N/A	0.0	14.3	14.8	14.4	14.1	14.3	13.4	13.6

Table B.6a (cont'd.)

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MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR10
1245	Dnn	261.	263.	0.	261.	255.	255.	254.	259.	256.	N/A
	10m	14.2	13.2	0.0	16.6	16.4	16.9	15.8	17.2	15.7	N/A
	6m	14.4	13.1	0.0	16.8	17.0	17.1	16.0	16.9	16.4	15.6
	3m	12.7	N/A	0.0	15.6	16.1	15.3	14.4	15.0	13.9	14.4
1300	Dnn	261.	264.	0.	264.	259.	259.	256.	262.	259.	N/A
	10m	13.7	14.0	0.0	16.9	16.6	16.8	15.7	16.9	15.8	N/A
	6m	13.9	13.8	0.0	17.1	17.2	17.1	16.2	16.6	16.5	15.5
	3m	12.1	N/A	0.0	15.9	16.4	15.3	14.4	14.9	14.1	14.4
1315	Dnn	262.	262.	0.	263.	258.	258.	261.	262.	260.	N/A
	10m	13.6	8.0	0.0	16.4	16.1	16.8	16.1	17.3	16.2	N/A
	6m	13.8	13.4	0.0	16.7	16.9	17.1	17.0	17.0	16.9	15.8
	3m	12.1	N/A	0.0	15.5	16.2	15.4	15.2	15.2	14.3	14.6
1330	Dnn	263.	267.	0.	265.	260.	260.	260.	264.	261.	N/A
	10m	14.2	13.3	0.0	16.3	15.9	16.3	15.9	16.4	15.5	N/A
	6m	14.4	13.1	0.0	16.5	16.6	16.6	16.8	16.1	16.2	15.2
	3m	12.7	N/A	0.0	15.4	16.0	14.9	14.9	14.4	13.7	14.2
1345	Dnn	262.	264.	0.	263.	259.	259.	262.	263.	261.	N/A
	10m	14.0	13.7	0.0	17.4	17.0	17.5	14.8	18.1	17.0	N/A
	6m	14.2	13.7	0.0	17.6	17.7	17.9	16.4	17.8	17.7	16.4
	3m	12.6	N/A	0.0	16.4	17.0	16.1	14.6	15.9	14.9	15.3
1400	Dnn	263.	266.	0.	265.	259.	260.	261.	264.	261.	N/A
	10m	13.9	14.1	0.0	17.1	16.9	17.3	15.7	17.9	17.0	N/A
	6m	14.1	14.0	0.0	17.3	17.5	17.7	17.3	17.7	17.7	16.3
	3m	12.5	N/A	0.0	16.1	16.9	15.8	15.4	15.8	15.0	15.2
1415	Dnn	263.	266.	0.	264.	259.	259.	262.	263.	261.	N/A
	10m	13.8	14.1	0.0	17.5	17.3	17.7	16.7	18.6	17.7	N/A
	6m	14.1	14.0	0.0	17.8	17.9	18.1	18.3	18.3	18.5	16.9
	3m	12.5	N/A	0.0	16.6	17.2	16.2	16.3	16.3	15.7	15.7
1430	Dnn	259.	261.	0.	260.	256.	256.	261.	260.	257.	N/A
	10m	13.5	13.6	0.0	17.2	16.8	17.3	16.5	17.7	17.1	N/A
	6m	13.8	13.6	0.0	17.5	17.6	17.8	18.1	17.6	17.9	16.3
	3m	12.2	N/A	0.0	16.3	16.9	16.0	16.0	15.8	15.1	15.1
1445	Dnn	259.	261.	0.	260.	254.	255.	259.	259.	257.	N/A
	10m	13.7	13.3	0.0	16.5	16.2	16.9	15.9	17.9	17.1	N/A
	6m	13.9	13.2	0.0	16.8	17.0	17.4	17.5	17.7	17.9	16.3
	3m	12.2	N/A	0.0	15.6	16.5	15.7	15.7	15.8	15.2	15.1
1500	Dnn	259.	263.	0.	261.	256.	257.	257.	260.	258.	N/A
	10m	11.7	12.4	0.0	15.3	15.2	15.7	16.3	16.5	16.0	N/A
	6m	12.0	12.3	0.0	15.5	15.9	15.9	17.8	16.3	16.7	14.8
	3m	10.6	N/A	0.0	14.4	15.4	14.2	15.8	14.6	14.1	13.7
1515	Dnn	261.	263.	0.	0.	257.	258.	257.	262.	259.	N/A
	10m	11.4	11.8	0.0	0.0	14.5	15.1	15.1	15.4	14.4	N/A
	6m	11.8	11.8	0.0	0.0	15.3	15.3	16.4	15.3	15.0	14.0
	3m	10.4	N/A	0.0	0.0	15.0	13.8	14.6	13.7	12.7	13.1

Table B.6b Same as B.6a for tower 1. For all other towers speed-up is shown in place of speed.

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MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR10
1000	Drn	249.	249.	0.	253.	246.	246.	254.	251.	250.	N/A
	10m	5.5	1.22	0.00	1.58	1.71	1.86	1.95	1.90	1.79	N/A
	6m	5.7	1.14	0.00	1.57	1.73	1.83	1.94	1.80	1.80	1.56
	3m	4.6	N/A	0.00	1.78	1.95	2.03	2.10	1.94	1.87	1.77
1015	Drn	251.	257.	0.	256.	252.	251.	251.	256.	254.	N/A
	10m	6.1	0.97	0.00	1.25	1.28	1.41	1.60	1.43	1.35	N/A
	6m	6.2	0.92	0.00	1.24	1.31	1.41	1.63	1.37	1.37	1.17
	3m	5.2	N/A	0.00	1.38	1.57	1.54	1.72	1.46	1.40	1.33
1030	Drn	248.	251.	0.	253.	247.	247.	254.	252.	251.	N/A
	10m	7.6	0.84	0.00	1.01	1.02	1.11	1.18	1.12	1.06	N/A
	6m	7.7	0.80	0.00	1.01	1.06	1.11	1.21	1.08	1.08	0.94
	3m	6.5	N/A	0.00	1.12	1.25	1.19	1.26	1.14	1.08	1.02
1045	Drn	252.	254.	0.	256.	250.	250.	251.	254.	252.	N/A
	10m	7.8	0.97	0.00	1.26	1.26	1.34	0.99	1.37	1.30	N/A
	6m	8.1	0.93	0.00	1.25	1.28	1.32	1.01	1.30	1.31	1.17
	3m	6.9	N/A	0.00	1.37	1.44	1.40	1.01	1.36	1.30	1.28
1100	Drn	248.	252.	0.	256.	251.	251.	251.	256.	253.	N/A
	10m	8.8	0.95	0.00	1.25	1.28	1.35	1.09	1.35	1.27	N/A
	6m	8.9	0.93	0.00	1.26	1.33	1.35	1.10	1.30	1.29	1.19
	3m	7.6	N/A	0.00	1.36	1.46	1.43	1.13	1.33	1.27	1.29
1115	Drn	245.	248.	0.	251.	244.	243.	255.	249.	248.	N/A
	10m	8.6	1.08	0.00	1.25	1.32	1.45	1.33	1.47	1.38	N/A
	6m	8.8	1.04	0.00	1.26	1.36	1.44	1.33	1.41	1.40	1.25
	3m	7.6	N/A	0.00	1.36	1.52	1.51	1.38	1.45	1.37	1.34
1130	Drn	248.	250.	0.	253.	244.	243.	248.	247.	246.	N/A
	10m	9.2	0.98	0.00	1.21	1.28	1.37	1.30	1.44	1.37	N/A
	6m	9.4	0.95	0.00	1.26	1.33	1.38	1.30	1.39	1.41	1.21
	3m	8.1	N/A	0.00	1.35	1.48	1.45	1.35	1.43	1.39	1.31
1145	Drn	252.	255.	0.	255.	247.	246.	246.	250.	248.	N/A
	10m	11.6	0.80	0.00	1.04	1.10	1.16	1.09	1.16	1.08	N/A
	6m	11.8	0.78	0.00	1.06	1.13	1.16	1.08	1.12	1.12	1.04
	3m	10.3	N/A	0.00	1.14	1.25	1.19	1.11	1.14	1.09	1.10
1200	Drn	257.	257.	0.	256.	248.	248.	247.	252.	249.	N/A
	10m	11.6	0.96	0.00	1.15	1.22	1.29	1.11	1.32	1.23	N/A
	6m	11.9	0.92	0.00	1.16	1.25	1.27	1.10	1.26	1.25	1.17
	3m	10.4	N/A	0.00	1.24	1.37	1.32	1.13	1.29	1.20	1.23
1215	Drn	258.	258.	0.	257.	251.	251.	250.	255.	252.	N/A
	10m	11.7	1.00	0.00	1.26	1.32	1.38	1.19	1.40	1.31	N/A
	6m	12.0	0.97	0.00	1.26	1.36	1.38	1.19	1.35	1.34	1.26
	3m	10.3	N/A	0.00	1.35	1.47	1.43	1.22	1.39	1.31	1.34
1230	Drn	260.	262.	0.	260.	253.	253.	254.	257.	254.	N/A
	10m	13.7	0.82	0.00	1.10	1.09	1.15	1.14	1.19	1.10	N/A
	6m	13.9	0.92	0.00	1.11	1.13	1.15	1.15	1.15	1.14	1.05
	3m	12.2	N/A	0.00	1.17	1.22	1.18	1.16	1.18	1.10	1.11

Table B.6b (cont'd.)

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MST		TWR 1	TWR 2	TWR 3	TWR 4	TWR 5	TWR 6	TWR 7	TWR 8	TWR 9	TWR10
1245	Drn	261.	263.	0.	261.	255.	255.	254.	259.	256.	N/A
	10m	14.2	0.93	0.00	1.17	1.15	1.19	1.11	1.21	1.11	N/A
	6m	14.4	0.91	0.00	1.17	1.18	1.19	1.11	1.17	1.14	1.08
	3m	12.7	N/A	0.00	1.23	1.27	1.21	1.14	1.18	1.09	1.13
1300	Drn	261.	264.	0.	264.	259.	259.	256.	262.	259.	N/A
	10m	13.7	1.02	0.00	1.23	1.21	1.22	1.14	1.23	1.16	N/A
	6m	13.9	1.00	0.00	1.23	1.24	1.23	1.16	1.20	1.19	1.12
	3m	12.1	N/A	0.00	1.31	1.35	1.26	1.18	1.23	1.16	1.19
1315	Drn	262.	262.	0.	263.	258.	258.	261.	262.	260.	N/A
	10m	13.6	0.59	0.00	1.21	1.19	1.23	1.18	1.27	1.19	N/A
	6m	13.8	0.98	0.00	1.21	1.22	1.24	1.24	1.24	1.23	1.15
	3m	12.1	N/A	0.00	1.28	1.33	1.27	1.25	1.25	1.18	1.21
1330	Drn	263.	267.	0.	265.	260.	260.	260.	264.	261.	N/A
	10m	14.2	0.94	0.00	1.15	1.12	1.15	1.12	1.16	1.09	N/A
	6m	14.4	0.92	0.00	1.15	1.16	1.16	1.17	1.12	1.13	1.06
	3m	12.7	N/A	0.00	1.21	1.26	1.17	1.17	1.13	1.08	1.11
1345	Drn	262.	264.	0.	263.	259.	259.	262.	263.	261.	N/A
	10m	14.0	0.98	0.00	1.24	1.21	1.25	1.06	1.29	1.22	N/A
	6m	14.2	0.97	0.00	1.24	1.25	1.27	1.15	1.26	1.25	1.16
	3m	12.6	N/A	0.00	1.29	1.34	1.27	1.15	1.26	1.18	1.21
1400	Drn	263.	266.	0.	265.	259.	260.	261.	264.	261.	N/A
	10m	13.9	1.02	0.00	1.23	1.22	1.25	1.14	1.29	1.23	N/A
	6m	14.1	0.99	0.00	1.22	1.24	1.25	1.23	1.25	1.25	1.16
	3m	12.5	N/A	0.00	1.28	1.35	1.27	1.23	1.27	1.20	1.21
1415	Drn	263.	266.	0.	264.	259.	259.	262.	263.	261.	N/A
	10m	13.8	1.02	0.00	1.26	1.25	1.28	1.21	1.34	1.28	N/A
	6m	14.1	1.00	0.00	1.26	1.27	1.28	1.30	1.30	1.32	1.20
	3m	12.5	N/A	0.00	1.33	1.37	1.29	1.30	1.30	1.25	1.25
1430	Drn	259.	261.	0.	260.	256.	256.	261.	260.	257.	N/A
	10m	13.5	1.01	0.00	1.27	1.24	1.28	1.22	1.31	1.27	N/A
	6m	13.8	0.98	0.00	1.27	1.27	1.29	1.31	1.27	1.29	1.18
	3m	12.2	N/A	0.00	1.33	1.38	1.31	1.31	1.29	1.23	1.23
1445	Drn	259.	261.	0.	260.	254.	255.	259.	259.	257.	N/A
	10m	13.7	0.97	0.00	1.21	1.18	1.23	1.16	1.30	1.25	N/A
	6m	13.9	0.94	0.00	1.21	1.22	1.25	1.26	1.27	1.28	1.17
	3m	12.2	N/A	0.00	1.27	1.34	1.28	1.28	1.29	1.24	1.24
1500	Drn	259.	263.	0.	261.	256.	257.	257.	260.	258.	N/A
	10m	11.7	1.06	0.00	1.30	1.30	1.34	1.39	1.41	1.37	N/A
	6m	12.0	1.02	0.00	1.29	1.32	1.32	1.48	1.36	1.39	1.23
	3m	10.6	N/A	0.00	1.36	1.45	1.34	1.49	1.38	1.33	1.29
1515	Drn	261.	263.	0.	0.	257.	258.	257.	262.	259.	N/A
	10m	11.4	1.03	0.00	0.00	1.27	1.32	1.33	1.35	1.26	N/A
	6m	11.8	1.00	0.00	0.00	1.29	1.39	1.39	1.30	1.27	1.19
	3m	10.4	N/A	0.00	0.00	1.44	1.33	1.40	1.32	1.22	1.25

The data from run 10 have already been summarized in the calculation of z_0 in Section 4.2.

B.3 3m Tower Data

Figures 5 and 6 and Table 3 give the locations of the 3m towers for the various experimental runs. Table 4 reports the times of operation, averaging (i.e., reading) interval and ancillary information for the data runs.

Each 3m tower provides an averaged speed (with an averaging interval of 10 or 15 min) by measuring wind-run for the specified time interval. As described in Section 3.8.2, the towers were not sampled simultaneously but sequentially, which means that the averages reported have slightly offset start and finish times. This offset is usually equal to or less than 4 min. Tables B.7 through B.19 report the averaged wind speed data from the 3m tower system. The time given is the time (nominal) at the start of the averaging period. V-REF is the averaged (over the same nominal interval) wind speed from the 3m Gill cup anemometer of 10m tower 1 (the reference tower). Of the two figures shown for each tower and each interval, the upper is the average wind speed while the lower is the speed-up, calculated as the quotient of the average wind speed and the corresponding V-REF. The bottom row of the table lists the average of the individual speed-ups from each tower. A value of 0.00 in the velocity column indicates that the velocity for that interval could not be obtained - usually because of equipment failure.

For runs 0A, 1A and 3A no reference velocities were available since 10m tower number 1 had not yet been rendered fully operational. In the tables for those runs, there are no speed-up entries.

B.4 U2A Hilltop and Airport Anemometer Data

Table B.20 through B.29 contain the data collected at half-hourly intervals at Pincher Creek Airport 12 km WNW of Kettles Hill and at the hilltop instrument trailer. The airport data were supplied by Bob Dobbs of the AES Weather Station at Pincher Creek Airport. The wind speed there was measured by a U2A anemometer (at 10m height) identical to the one placed on the hilltop. The hilltop data were recorded (when possible) by the occupants of the hilltop instrument trailer. The temperature was measured with a mercury thermometer accurate to 0.1°C.

Table B.7 Run 0a (12/02/81) average wind speeds from the 3m towers for the averaging intervals indicated. No reference velocities were available to calculate speed-ups.

VELOCITY

	TOWER	A	B	C	D	E	F	G	H	I	J
TIME	V-REF										
1540		12.72	11.62	12.61	12.22	0.00	12.09	12.17	11.74	0.00	10.67
1555		13.32	12.44	12.87	12.22	0.00	11.74	12.24	11.88	0.00	10.77
1610		11.99	11.20	12.15	11.66	0.00	10.93	11.57	10.99	0.00	9.71
1625		11.42	10.60	11.50	10.83	0.00	10.56	10.86	10.30	0.00	9.33
1640		11.06	10.55	11.20	10.73	15.58	0.00	0.00	0.00	0.00	0.00

Table B.8 Run 1a (14/02/81) average wind speeds from the 3m towers for the averaging intervals indicated. No reference velocities were available to calculate speed-ups.

	TOWER	A	B	C	D	E	F	G	H	I	J
TIME	V-REF										
1300		17.84	16.46	16.96	0.00	15.47	15.43	16.31	16.23	19.11	0.00
1310		18.44	16.33	17.97	20.14	17.77	17.57	17.68	17.15	19.22	15.53
1320		19.12	17.85	18.16	21.55	17.66	17.75	17.83	16.67	19.59	15.10
1330		20.06	18.13	19.02	21.55	18.10	0.00	18.31	17.31	20.49	16.35
1340		20.04	18.43	19.36	22.36	18.75	0.00	18.20	17.46	20.97	16.53
1350		21.23	19.17	20.68	24.57	19.94	0.00	19.45	18.00	21.76	18.36
1400		21.30	19.34	20.54	24.26	20.03	21.65	18.87	17.67	22.24	18.38
1410		19.46	17.76	19.02	22.42	19.45	18.77	0.00	16.84	20.40	16.75
1420		19.31	17.67	19.17	22.34	18.48	18.84	0.00	16.61	20.40	14.78
1430		15.17	14.16	15.85	16.45	15.42	15.10	0.00	13.63	14.78	11.99
1440		14.75	13.68	14.48	14.73	13.68	13.44	0.00	12.74	14.86	11.85
1450		11.46	10.23	11.50	11.43	11.73	11.02	0.00	10.16	0.00	9.04

Table B.11 Run 3b (16/02/81) average wind speeds and speed-ups from the 3m towers for the averaging intervals indicated.

VELOCITY
SPEED-UP

		TOWER	A	B	C	D	E	F	G	H	I	J
TIME	V-REF											
1340	8.41	10.24	0.00	9.61	10.87	9.14	9.27	9.44	9.28	10.79	9.49	
		1.22	0.00	1.14	1.29	1.09	1.10	1.12	1.10	1.28	1.13	
1350	8.79	11.72	0.00	11.33	10.87	10.39	10.06	10.17	10.84	12.02	11.02	
		1.33	0.00	1.29	1.24	1.18	1.14	1.16	1.23	1.37	1.25	
1400	8.82	10.99	0.00	10.95	10.87	9.81	9.82	9.89	10.26	11.03	10.32	
		1.25	0.00	1.24	1.23	1.11	1.11	1.12	1.16	1.25	1.17	
1410	10.29	11.03	0.00	10.15	10.87	10.32	10.30	10.39	10.28	11.36	10.08	
		1.07	0.00	0.99	1.06	1.00	1.00	1.01	1.00	1.10	0.98	
1420	10.85	12.31	0.00	11.60	11.49	10.93	11.00	11.25	11.01	12.46	11.32	
		1.13	0.00	1.07	1.06	1.01	1.01	1.04	1.01	1.15	1.04	
1430	9.45	11.48	0.00	11.44	11.49	10.39	10.04	10.39	10.76	11.69	11.00	
		1.22	0.00	1.21	1.22	1.10	1.06	1.10	1.14	1.24	1.16	
1440	9.23	11.40	0.00	10.81	11.24	9.81	9.56	10.06	10.20	11.58	10.45	
		1.23	0.00	1.17	1.22	1.06	1.04	1.09	1.10	1.25	1.13	
1450	8.59	10.69	0.00	10.47	10.15	9.72	9.82	9.98	10.07	10.90	10.28	
		1.24	0.00	1.22	1.18	1.13	1.14	1.16	1.17	1.27	1.20	
1500	8.62	9.90	0.00	9.90	10.15	8.98	8.90	9.20	9.51	10.22	9.57	
		1.15	0.00	1.15	1.18	1.04	1.03	1.07	1.10	1.19	1.11	
AVERAGE SPEED-UP		1.21	0.00	1.16	1.19	1.08	1.07	1.10	1.11	1.23	1.13	

Table B.12 Run 5a (18/02/81) average wind speeds and speed-ups from the 3m towers for the averaging intervals indicated.

VELOCITY

SPEED-UP

	TOWER	A	B	C	D	E	F	G	H	I	J
TIME	V-REF										
1300	9.11	10.03 1.10	9.62 1.06	10.20 1.12	9.69 1.06	9.81 1.08	10.65 1.17	10.17 1.12	12.57 1.38	11.27 1.24	11.75 1.29
1315	9.21	8.99 0.98	9.34 1.01	10.11 1.10	9.77 1.06	10.26 1.11	11.13 1.21	11.25 1.22	13.21 1.43	12.70 1.38	12.95 1.41
1330	9.76	9.52 0.98	10.16 1.04	10.62 1.09	10.33 1.06	10.79 1.11	11.76 1.21	11.72 1.20	14.34 1.47	12.96 1.33	13.33 1.37
1345	9.76	9.84 1.01	10.27 1.05	10.55 1.08	10.02 1.03	10.41 1.07	11.52 1.18	11.55 1.18	14.11 1.45	12.96 1.33	13.31 1.36
AVERAGE SPEED-UP		1.02	1.04	1.10	1.05	1.09	1.19	1.18	1.43	1.32	1.36

Table B.13 Run 5b (18/02/81) average wind speeds and speed-ups from the 3m towers for the averaging intervals indicated.

VELOCITY

SPEED-UP

	TOWER	A	B	C	D	E	F	G	H	I	J
TIME	V-REF										
1510	10.90	10.33 0.95	10.79 0.99	11.16 1.02	10.46 0.96	10.81 0.99	11.94 1.10	12.00 1.10	14.32 1.31	13.09 1.20	13.33 1.22
1525	10.67	10.37 0.97	10.88 1.02	11.52 1.08	10.77 1.01	11.04 1.03	12.15 1.14	12.41 1.16	14.98 1.40	13.73 1.29	14.41 1.35
1540	11.45	11.12 0.97	11.79 1.03	12.15 1.06	11.56 1.01	12.11 1.06	13.25 1.16	13.12 1.15	16.19 1.41	14.73 1.29	14.74 1.29
1555	11.80	10.95 0.93	12.09 1.02	12.49 1.06	11.70 0.99	12.22 1.04	13.36 1.13	13.44 1.14	16.15 1.37	14.69 1.24	15.02 1.27
1610	12.25	10.48 0.86	11.53 0.94	12.32 1.01	11.89 0.97	12.18 0.99	13.07 1.07	12.62 1.03	15.25 1.25	14.32 1.17	14.25 1.16
1625	11.15	9.26 0.83	10.10 0.91	11.69 1.05	10.93 0.98	11.49 1.03	11.59 1.04	11.89 1.07	14.67 1.32	13.53 1.21	13.86 1.24
AVERAGE SPEED-UP		0.92	0.99	1.05	0.99	1.02	1.10	1.11	1.34	1.23	1.26

Table B.14 Run 6a (19/02/81) average wind speeds and speed-ups from the 3m towers for the averaging intervals indicated.

VELOCITY

SPEED-UP

	TOWER	A	B	C	D	E	F	G	H	I	J
TIME	V-REF										
1520	6.81	9.07 1.33	10.51 1.54	11.50 1.69	10.50 1.54	0.00 0.00	7.48 1.10	6.79 1.00	7.89 1.16	8.80 1.29	8.92 1.31
1535	8.78	11.25 1.28	12.94 1.47	13.79 1.57	11.68 1.33	0.00 0.00	10.41 1.19	10.34 1.18	8.95 1.02	9.37 1.07	10.06 1.15
1550	7.86	10.39 1.32	12.03 1.53	12.47 1.59	12.74 1.62	0.00 0.00	9.16 1.17	8.77 1.12	8.55 1.09	8.93 1.14	9.43 1.20
1605	6.30	9.07 1.44	10.25 1.63	10.93 1.74	9.96 1.58	0.00 0.00	8.18 1.30	7.35 1.17	7.95 1.26	8.06 1.28	8.35 1.33
1620	6.90	9.82 1.42	11.10 1.61	11.88 1.72	10.58 1.53	0.00 0.00	8.64 1.25	8.32 1.21	8.39 1.22	8.74 1.27	9.35 1.36
1635	6.77	9.67 1.43	10.86 1.60	11.16 1.65	9.90 1.46	0.00 0.00	9.12 1.35	8.32 1.23	8.18 1.21	8.65 1.28	9.67 1.43
AVERAGE	SPEED-UP	1.37	1.56	1.66	1.51	0.00	1.22	1.15	1.16	1.22	1.29

Table B.15 Run 7A (20/02/81) average wind speeds and speed-ups from the 3m towers for the averaging intervals indicated.

VELOCITY SPEED-UP											
	TOWER	A	B	C	D	E	F	G	H	I	J
TIME	V-REF										
1030	10.84	10.71 0.99	12.44 1.15	12.36 1.14	12.36 1.14	0.00 0.00	11.70 1.08	11.20 1.03	10.88 1.00	10.66 0.98	12.24 1.13
1045	10.65	12.06 1.13	12.48 1.17	12.38 1.16	12.78 1.20	0.00 0.00	11.74 1.10	11.46 1.08	11.40 1.07	11.65 1.09	11.75 1.10
1100	10.57	12.53 1.19	13.31 1.26	12.91 1.22	13.65 1.29	0.00 0.00	11.89 1.13	11.55 1.09	11.61 1.10	11.34 1.07	13.15 1.24
1115	10.41	11.01 1.06	11.96 1.15	11.77 1.13	12.72 1.22	0.00 0.00	11.65 1.12	11.14 1.07	11.22 1.08	11.54 1.11	11.79 1.13
1130	11.34	11.44 1.01	13.05 1.15	13.03 1.15	13.26 1.17	0.00 0.00	12.50 1.10	12.02 1.06	12.09 1.07	12.37 1.09	12.79 1.13
1145	11.67	12.51 1.07	13.72 1.18	13.22 1.13	13.32 1.14	13.23 1.13	12.26 1.05	11.72 1.00	11.97 1.03	12.02 1.03	13.25 1.14
AVERAGE SPEED-UP		1.07	1.18	1.16	1.19	1.13	1.10	1.06	1.06	1.06	1.15

Table B.16 Run 7b (20/02/81) average wind speeds and speed-ups from the 3m towers for the averaging intervals indicated.

VELOCITY SPEED-UP											
	TOWER	A	B	C	D	E	F	G	H	I	J
TIME	V-REF										
1330	12.28	12.83 1.04	14.13 1.15	13.79 1.12	13.38 1.09	13.92 1.13	13.44 1.09	12.82 1.04	12.42 1.01	12.98 1.06	12.58 1.02
1345	12.52	13.53 1.08	15.07 1.20	15.20 1.21	14.29 1.14	14.15 1.13	13.22 1.06	12.67 1.01	12.86 1.03	12.89 1.03	13.84 1.11
1400	12.23	13.70 1.12	15.24 1.25	13.62 1.11	15.31 1.25	14.10 1.15	13.20 1.08	12.56 1.03	12.94 1.06	13.00 1.06	13.29 1.09
1415	12.11	13.40 1.11	14.09 1.16	14.21 1.17	16.51 1.36	13.88 1.15	12.96 1.07	12.17 1.01	12.09 1.00	12.85 1.06	13.46 1.11
1430	11.59	13.70 1.18	14.81 1.28	14.61 1.26	17.36 1.50	14.26 1.23	13.20 1.14	12.78 1.10	13.03 1.12	13.40 1.16	13.64 1.18
1445	11.74	13.74 1.17	14.26 1.22	13.85 1.18	15.20 1.30	13.50 1.15	0.00 0.00	12.97 1.10	12.78 1.09	12.50 1.06	13.17 1.12
AVERAGE SPEED-UP		1.12	1.21	1.18	1.27	1.16	1.09	1.05	1.05	1.07	1.10

Table B.17 Run 8a (21/02/81) average wind speeds and speed-ups from the 3m towers for the averaging intervals indicated.

VELOCITY ----- SPEED-UP		TOWER	A	B	C	D	E	F	G	H	I	J
TIME	V-REF											
1400	10.98		12.31 1.12	12.27 1.12	12.23 1.11	12.99 1.18	13.70 1.25	13.05 1.19	12.34 1.12	11.65 1.06	11.43 1.04	13.92 1.27
1415	11.03		11.95 1.08	12.18 1.10	11.88 1.08	12.26 1.11	13.27 1.20	12.11 1.10	11.91 1.08	11.70 1.06	12.02 1.09	13.03 1.18
1430	11.38		12.98 1.14	12.55 1.10	12.59 1.11	13.50 1.19	14.46 1.27	13.44 1.18	12.78 1.12	11.88 1.04	12.04 1.06	14.01 1.23
1445	11.44		12.87 1.12	12.75 1.11	12.19 1.07	13.05 1.14	14.19 1.24	12.87 1.13	12.30 1.08	11.47 1.00	11.41 1.00	14.05 1.23
1500	10.61		12.51 1.18	12.38 1.17	12.11 1.14	12.65 1.19	14.06 1.32	12.79 1.21	11.76 1.11	11.11 1.05	11.12 1.05	13.76 1.30
1515	10.41		11.55 1.11	11.66 1.12	11.39 1.09	11.80 1.13	12.92 1.24	12.15 1.17	11.74 1.13	11.03 1.06	11.38 1.09	13.25 1.27
1530	9.70		11.38 1.17	11.59 1.20	11.14 1.15	11.66 1.20	12.87 1.33	11.50 1.19	11.12 1.15	10.38 1.07	10.31 1.06	12.60 1.30
1545	9.99		10.63 1.06	10.40 1.04	10.51 1.05	10.91 1.09	11.51 1.15	11.50 1.15	11.03 1.10	10.49 1.05	10.62 1.06	11.44 1.14
AVERAGE SPEED-UP			1.12	1.12	1.10	1.16	1.25	1.16	1.11	1.05	1.06	1.24

Table B.18 Run 9a (22/02/81) average wind speeds and speed-ups from the 3m towers for the averaging intervals indicated.

VELOCITY												
SPEED-UP												
		TOWER	A	B	C	D	E	F	G	H	I	J
TIME	V-REF											
1100	7.63		9.18 1.20	8.92 1.17	9.46 1.24	9.50 1.25	10.28 1.35	9.10 1.19	8.86 1.16	8.64 1.13	8.21 1.08	8.60 1.13
1115	7.59		8.60 1.13	8.99 1.18	9.21 1.21	9.79 1.29	10.59 1.40	9.10 1.20	9.03 1.19	8.68 1.14	8.58 1.13	8.88 1.17
1130	8.09		9.41 1.16	9.25 1.14	9.59 1.18	10.33 1.28	11.08 1.37	9.40 1.16	9.52 1.18	9.03 1.12	8.93 1.10	8.88 1.10
1145	10.34		9.82 0.95	9.99 0.97	10.97 1.06	10.77 1.04	11.53 1.12	9.84 0.95	10.00 0.97	10.34 1.00	10.11 0.98	10.47 1.01
1200	10.35		10.91 1.05	11.05 1.07	10.66 1.03	12.36 1.19	13.41 1.30	11.00 1.06	11.05 1.07	10.86 1.05	10.20 0.99	10.63 1.03
1215	10.32		12.19 1.18	12.07 1.17	12.13 1.18	13.21 1.28	14.28 1.38	12.09 1.17	11.98 1.16	11.86 1.15	11.10 1.08	11.48 1.11
AVERAGE SPEED-UP			1.11	1.12	1.15	1.22	1.32	1.12	1.12	1.10	1.06	1.09

Table B.19 Run 9b (22/02/81) average wind speeds and speed-ups from the 3m towers for the averaging intervals indicated.

VELOCITY ----- SPEED-UP												
		TOWER	A	B	C	D	E	F	G	H	I	J
TIME	V-REF											
1330	12.73		13.66 1.07	13.07 1.03	12.51 0.98	13.40 1.05	14.06 1.10	13.27 1.04	13.18 1.04	13.36 1.05	0.00 0.00	13.52 1.06
1345	12.64		13.74 1.09	13.50 1.07	13.50 1.07	14.33 1.13	15.58 1.23	13.90 1.10	13.94 1.10	13.86 1.10	0.00 0.00	13.66 1.08
1400	12.50		13.81 1.10	13.85 1.11	13.68 1.09	14.23 1.14	15.53 1.24	14.08 1.13	14.13 1.13	13.80 1.10	0.00 0.00	14.09 1.13
1415	12.49		14.62 1.17	13.96 1.12	13.71 1.10	14.35 1.15	15.47 1.24	14.64 1.17	14.69 1.18	13.88 1.11	0.00 0.00	13.74 1.10
1430	12.24		13.77 1.12	13.64 1.11	13.68 1.12	14.31 1.17	0.00 0.00	13.64 1.11	13.57 1.11	13.82 1.13	0.00 0.00	13.76 1.12
1445	12.25		13.57 1.11	13.37 1.09	13.24 1.08	13.79 1.13	13.30 1.09	13.84 1.13	12.95 1.06	13.86 1.13	0.00 0.00	13.05 1.07
1500	10.59		0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	11.98 1.13	12.83 1.21	12.58 1.19	12.17 1.15	0.00 0.00	11.93 1.13
1515	10.41		0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	11.93 1.15	11.96 1.15	11.83 1.14	12.13 1.17	0.00 0.00	11.77 1.13
AVERAGE SPEED-UP			1.11	1.09	1.07	1.13	1.17	1.13	1.12	1.12	0.00	1.10

Table B.20 Data collected at the hilltop location (subscript H) adjacent to the 10m tower 8 and at the airport (subscript A).

V = Speed (m s^{-1}) D = Direction ($^{\circ}\text{true}$)
T = Air Temperature ($^{\circ}\text{C}$)

Run 1a, 14/02/81

Time LST	Hilltop			Airport					
	V _H	D _H	T _H	V _A	D _A	T _A	V _H /V _A	D _H -D _A	T _H -T _A
1200	14	248	-	13	250	7.5	1.04	- 2	-
1230	19	253	7.2	-	-	-	-	-	-
1300	21	248	7.0	13	250	7.7	1.60	- 2	-0.7
1330	23	248	7.0	-	-	-	-	-	-
1400	27	238	6.7	23	250	7.9	1.20	-12	-1.2
1430	23	243	6.9	-	-	-	-	-	-
1500	15	258	7.0	24	250	7.0	0.64	+ 8	0.0
AVG.	20.3	248	7.0	18.3	250	7.5	1.11	- 2	-0.6

Table B.21

Same as Table B.20 except:
Run 2a 15/02/81

Time LST	Hilltop			Airport					
	V _H	D _H	T _H	V _A	D _A	T _A	V _H /V _A	D _H -D _A	T _H -T _A
0900	14	260	-	9	240	3.5	1.56	20	-
0930	14	250	-	12	250	3.7	1.22	0	-
1000	14	245	-	10	250	4.0	1.42	- 5	-
1030	14	255	-	11	250	4.4	1.23	5	-
1100	18	240	-	12	250	4.6	1.46	-10	-
*1138	17	240	-	11	250	4.8	-	-	-
1200	17	235	-	14	250	4.7	1.22	-15	-
1230	19	230	-	11	240	6.4	1.76	-10	-
1300	17	240	-	19	250	6.6	0.92	-10	-
1330	15	230	-	20	250	6.0	0.79	-20	-
1400	15	240	7.7	20	250	6.0	0.79	-10	1.7
1430	22	240	7.0	14	240	6.2	1.50	0	0.8
1500	21	245	5.7	11	250	5.5	1.82	- 5	0.2
1530	18	245	6.6	18	250	5.7	1.03	- 5	0.9
1600	20	245	5.0	10	260	5.5	1.90	-15	-0.5
1630	20	250	-	13	250	5.0	1.52	0	-
AVG.	17.2	243	6.4	13.5	249	5.8	1.34	- 5	+0.6

Table B.22 Same as Table B.20 except:
Runs 3a, 3b 16/02/81

Time LST	Hilltop			Airport					
	V _H	D _H	T _H	V _A	D _A	T _A	V _H /V _A	D _H -D _A	T _H -T _A
1030	3	320	-	8	250	5.5	0.31	-	-
1100	7	330	7.8	7	250	6.0	1.00	-	-
1130	8	320	6.1	7	240	6.8	1.07	-	-
1200	3	010	8.8	11	240	8.0	0.23	-	-
1230	5	270	10.8	10	260	8.4	0.45	-	-
1300	10	250	-	11	240	8.6	0.95	10	-
1330	11	240	10.6	11	250	8.0	1.00	-10	2.6
1400	-	-	-	11	250	7.8	-	-	-
1430	14	260	9.7	9	240	7.6	1.56	20	2.1
1500	13	260	8.7	9	250	7.5	1.47	10	1.2
1530	14	255	8.7	11	260	7.5	1.23	- 5	1.2
1600	17	250	6.5	12	260	7.4	1.43	-10	-0.9
1630	14	250	6.4	11	260	7.1	1.29	-10	-0.7
1700	9	225	5.8	5	250	6.7	1.89	-25	-0.9
1730	7	260	5.2	-	-	-	-	-	-
1800	18	215	5.0	-	-	-	-	-	-
AVG. (1300-1700)	12.8	249	8.5	9.8	251	7.6	1.35	-2	+0.7

Table B.23 Same as Table B.20 except:
Run 4 17/02/81

Time LST	Hilltop			Airport					
	V _H	D _H	T _H	V _A	D _A	T _A	V _H /V _A	D _H -D _A	T _H -T _A
0900	18	250	5.5	6	260	5.0	-	-	-
0930	-	-	-	13	250	5.0	-	-	-
1000	10	280	5.0	11	240	5.2	.95	40	- 0.2
1030	20	255	5.1	10	240	5.9	1.95	15	- 0.8
1100	14	255	6.0	9	230	6.2	1.56	25	- 0.2
1130	14	260	6.3	12	250	6.4	1.22	10	- 0.1
1200	13	250	6.6	10	230	6.5	1.25	20	+ 0.1
1230	12	245	7.5	11	240	7.1	1.05	5	+ 0.4
1300	15	255	7.9	11	250	7.4	1.43	5	+ 0.5
1330	15	255	7.5	-	-	-	-	-	-
1400	15	265	7.0	12	240	7.0	1.21	25	0.0
1430	18	250	6.6	9	230	7.1	1.94	20	- 0.5
1500	17	250	6.0	13	240	7.0	1.32	10	- 1.0
1535	15	250	7.0	13	250	6.2	-	-	-
1600	15	250	6.3	14	240	6.6	1.07	10	- 0.3
1630	15	250	4.7	9	240	5.4	1.61	10	- 0.7
1700	17	255	4.0	9	240	4.9	1.83	15	- 0.9
AVG. (1000-1700)	15.1	255	6.1	10.9	239	6.4	1.41	16	- 0.4

Table B.24

Same as Table B.20 except:
Runs 5a, 5b 18/02/81

Time LST	Hilltop			Airport					
	V _H	D _H	T _H	V _A	D _A	T _A	V _H /V _A	D _H -D _A	T _H -T _A
1000	14	220	5.8	10	240	5.4	1.47	-20	+0.4
1030	12	250	6.2	14	240	6.0	0.82	10	+0.2
1100	13	255	5.3	14	230	5.6	0.93	25	-0.3
1130	14	280	4.8	12	270	5.3	1.17	10	-0.5
1200	15	260	0.3	11	270	1.9	1.43	-10	-1.6
1230	13	260	2.7	9	240	2.2	1.47	20	+0.5
1300	14	250	4.0	8	240	5.0	1.75	10	-1.0
1330	15	255	5.8	10	240	5.4	1.58	15	+0.4
1400	15	250	6.6	11	250	6.7	1.36	0	-0.1
1430	15	250	6.8	9	260	7.0	1.76	-10	-0.2
1500	15	250	7.3	9	260	7.0	1.67	-10	+0.3
1530	18	255	7.2	9	240	7.6	2.06	15	-0.4
1600	18	250	6.6	10	250	7.2	1.84	0	-0.6
1630	18	255	5.5	9	250	5.8	1.94	5	-0.3
1700	19	260	4.3	12	240	5.0	1.57	20	-0.7
AVG.	15.4	253	5.3	10.5	248	5.5	1.52	5	-0.3

Table B.25

Same as Table B.20 except:
Run 6a 19/02/81

Time LST	Hilltop			Airport					
	V_H	D_H	T_H	V_A	D_A	T_A	V_H/V_A	D_H-D_A	T_H-T_A
1100	10	220	10.0	3	280	7.5	3.33	-60	2.5
1130	13	220	11.0	4	280	7.8	3.13	-60	3.2
1200	17	215	11.0	6	250	8.6	2.75	-35	2.4
1230	14	220	11.7	5	250	8.6	2.80	-30	3.1
1300	21	270	3.8	9	250	5.3	-	-	-
1330	14	230	4.9	8	230	5.7	1.75	0	-0.8
1400	13	220	5.8	8	230	6.5	1.67	-10	-0.7
1430	15	220	5.6	11	230	6.0	1.43	-10	-0.4
1500	13	230	5.4	9	220	5.1	1.44	10	+0.3
1530	13	210	4.5	8	210	5.0	1.56	0	-0.5
1600	14	215	4.5	8	220	5.3	1.87	-5	-0.8
1630	14	220	4.2	8	230	4.8	1.75	-10	-0.6
AVG. (1330-1700)	14.0	221	5.0	8.6	224	5.5	1.64	-3	-0.5

Table B.26

Same as Table B.20 except:
Run 7a, 7b 20/02/81

Time LST	Hilltop			Airport					
	V _H	D _H	T _H	V _A	D _A	T _A	V _H /V _A	D _H -D _A	T _H -T _A
0900	15	260	1.5	14	240	1.5	1.11	20	0.0
0930	15	260	1.5	12	240	3.4	1.30	20	-1.9
1000	15	260	2.1	13	240	2.8	1.15	20	-0.7
1030	15	260	3.4	13	240	3.4	1.20	20	0.0
1100	16	260	3.2	10	250	3.7	1.63	10	-0.5
1140	18	260	-	11	250	4.0	1.62	10	-
1200	16	250	4.3	13	240	4.2	1.23	10	0.1
1234	21	250	-	12	230	4.6	1.67	20	-
1300	17	255	4.5	14	240	4.6	1.18	15	-0.1
1330	18	260	4.6	12	250	4.6	1.46	10	0.0
1400	20	260	4.2	13	260	5.0	1.52	0	-0.8
1430	19	260	4.3	14	250	4.2	1.37	10	0.1
1500	17	250	4.1	15	230	4.2	1.17	20	-0.1
1530	17	250	3.9	12	250	4.3	1.43	0	-0.4
1600	18	250	3.6	14	240	4.1	1.30	10	-0.5
AVG.	16.9	257	3.5	13.0	244	3.9	1.31	13	-0.4

Table B.27 Same as Table B.20 except:
Run 8a, 21/02/81

Time LST	Hilltop			Airport					
	V _H	D _H	T _H	V _A	D _A	T _A	V _H /V _A	D _H -D _A	T _H -T _A
1130	15	265	4.6	9	230	4.4	1.76	35	0.2
1200	15	260	5.0	14	250	4.6	1.07	10	0.4
1230	18	260	5.2	13	240	4.5	1.35	20	0.7
1300	19	260	5.2	15	250	4.8	1.28	10	0.4
1330	20	255	5.2	16	250	5.1	1.22	5	0.1
1400	18	265	5.6	10	250	5.0	1.84	15	0.6
1430	18	255	5.4	12	250	5.4	1.52	5	0.0
1500	19	265	5.3	12	240	5.2	1.57	25	0.1
1530	14	260	4.6	10	240	5.1	1.40	20	-0.5
1600	16	260	4.6	9	250	4.4	1.88	10	0.2
1630	-	-	-	10	260	4.3	-	-	-
1700	16	270	3.5	12	250	4.0	1.29	20	-0.5
AVG.	17.2	261	4.9	12.9	245	4.8	1.47	16	0.1

Table B.28 Same as Table B.20 except:
Runs 9a, 9b 22/02/81

Time LST	Hilltop			Airport					
	V _H	D _H	T _H	V _A	D _A	T _A	V _H /V _A	D _H -D _A	T _H -T _A
1000	12	250	3.9	12	240	4.6	1.00	10	-0.7
1030	-	-	-	13	240	4.7	-	-	-
1100	13	255	5.6	11	240	5.6	1.14	15	0.0
1130	13	240	6.3	10	230	5.8	1.25	10	0.5
1200	14	245	7.6	14	230	6.8	1.00	15	0.8
1230	18	250	7.5	9	230	8.9	2.00	20	-1.4
1300	21	255	9.0	9	240	9.5	2.22	15	-0.5
1330	18	260	9.3	11	250	9.6	1.67	10	-0.3
1400	21	255	10.2	13	250	9.8	1.60	5	0.4
1430	20	255	10.4	14	250	10.3	1.41	5	0.1
1500	19	250	10.0	12	260	10.6	1.61	-10	-0.6
1530	15	260	10.6	12	260	10.5	1.30	0	0.1
1600	16	265	9.7	13	260	10.3	1.28	5	-0.6
AVG.	16.6	253	8.3	11.6	245	8.5	1.46	8	-0.2

Table B.29

Same as Table B.20 except:
Run 10, 23/02/81

Time LST	Hilltop			Airport					
	V _H	D _H	T _H	V _A	D _A	T _A	V _H /V _A	D _H -D _A	T _H -T _A
0830	10	270	2.2	5	250	2.9	1.90	20	-0.7
0900	7	275	2.0	6	240	3.2	1.17	35	-1.2
0935	8	265	2.9	7	260	4.5	1.15	5	-1.6
1000	8	275	4.6	6	240	3.2	1.25	35	1.4
1030	-	-	-	6	260	6.6	-	-	-
1110	6	290	7.9	3	270	7.7	2.20	20	0.2
1130	4	300	8.4	4	290	8.2	1.00	10	0.2
1200	8	060	4.9	2	320	7.4	4.00	100	-2.5
1234	10	065	4.4	5	080	7.6	2.22	-15	-3.2
1312	10	060	-	5	080	7.4	2.00	-20	-
1330	-	-	-	7	070	5.8	-	-	-
1405	11	050	3.5	8	090	5.7	1.40	-40	-2.2
1435	11	050	-	8	090	5.5	1.31	-40	-
1500	11	060	3.0	8	100	4.6	1.40	-40	-1.6
1530	9	060	2.6	-	-	-	-	-	-
1600	-	-	-	7	080	3.6	-	-	-
1630	8	060	1.5	7	080	3.0	1.23	-20	-1.5
AVG.	8.6	324	4.0	5.9	325	5.4	1.71	4	-1.2

B.5 MRI Mechanical Weather Station Data

Table B.30 summarizes the data logged by the Mechanical Weather Station placed near 10m tower 5. It functioned continuously during the period 1500 on 17/02/81 to 2300 on 22/02/81.

B.6 Sonic Anemometer-Thermometer Data

The data collected at the hilltop location (10m tower 8) by the sonic anemometer will be detailed in a later report concerned with the measurement of turbulence during the experiment.

Table B.30

MRI Mechanical Weather Station Data. The wind speed data were calculated from wind-run information during the hour following the tabulated time and hence represent an averaged wind speed. The instantaneous direction applies to the time shown, as does the temperature.

Time	Wind Speed (m s ⁻¹)	Wind Direction (°)	Temp. (°C)	Time	Wind Speed (m s ⁻¹)	Wind Direction (°)	Temp. (°C)
<u>February 17, 1981</u>				<u>February 18, 1981</u>			
1500	13	240	5	0000	4	240	2
1600	14	230	5	0100	6	220	2
1700	12	235	3	0200	8	230	1
1800	13	225	3	0300	6	210	2
1900	12	230	3	0400	9	245	1
2000	13	245	3	0500	8	245	0
2100	13	225	3	0600	10	215	1
2200	11	230	2	0700	17	235	2
2300	8	215	2	0800	17	215	2
				0900	17	215	3
				1000	13	210	4
				1100	11	225	3
				1200	12	270	0
				1300		215	2
				1400	11	220	4
				1500	13	225	5
				1600	14	225	5
				1700		230	3
				1800	18	225	3
				1900	17	240	2
				2000	14	235	1
				2100	13	245	2
				2200	13	255	2
				2300	9	240	2

Table B.30 (continued)

Time	Wind Speed (m s ⁻¹)	Wind Direction (°)	Temp. (°C)	Wind Speed (m s ⁻¹)	Wind Direction (°)	Temp. (°C)
February 19, 1981				February 20, 1981		
0000	9	260	2	13	220	-3
0100	7	240	3	15	220	-2
0200	7	245	2	15	230	-1
0300	9	255	0	14	240	-1
0400	4	270	0	13	270	-1
0500	0	280	0	11	235	-2
0600	0	060	0	12	240	-2
0700	1	075	1	11	240	-2
0800	0	075	0	11	240	-2
0900	1	070	1	11	240	0
1000	4	200	5	13	240	0
1100	4	180	8	13	240	2
1200	9	205	9	13	235	1
1300	15	220	8	14	230	2
1400	14	210	3	16	230	3
1500	12	205	3	15	240	3
1600	13	195	3	16	225	2
1700	12	200	2	15	230	2
1800	11	225	2	17	230	0
1900	11	210	1	13	230	-1
2000	12	210	2	14	240	-1
2100	13	230	1	15	235	-1
2200	9	260	0	13	240	-1
2300	10	285	-2	14	240	-1

Table B.30 (continued)

Time	Wind Speed (m s ⁻¹)	Wind Direction (°)	Temp. (°C)	Wind Speed (m s ⁻¹)	Wind Direction (°)	Temp. (°C)
<u>February 21, 1981</u>				<u>February 22, 1981</u>		
0000	16	255	2	12	250	0
0100	17	245	-1	12	245	1
0200	16	240	-2	12	280	0
0300	15	245	-1	9	250	1
0400	14	245	-1	12	260	0
0500	14	240	-1	7	230	1
0600	13	230	-1	15	245	1
0700	11	240	-1	15	245	1
0800	12	240	-2	14	240	1
0900	13	245	-1	10	230	1
1000	13	230	1	9	225	3
1100	13	235	2	9	230	3
1200	14	230	3	9	220	5
1300	14	240	3	13	225	6
1400	15	240	4	15	240	8
1500	14	235	4	16	240	9
1600	14	250	3	15	240	9
1700	14	250	3	13	235	8
1800	13	240	2	11	230	7
1900	13	245	2	8	245	6
2000	13	250	1	10	240	5
2100	13	240	1	8	230	4
2200	13	245	1	1	270	4
2300	13	255	1	3	220	3

APPENDIX C

EXPERIMENT PERSONNEL

P.A. Taylor : Senior Research Scientist, Boundary Layer Research Division.

H.W. Teunissen : Research Scientist, Aerospace Meteorology Division, Meteorological Services Research Branch.

R.E. Mickle : Research Scientist, Boundary Layer Research Division.

J.R. Salmon : Contractor, 24 Heslop Drive, Toronto, Ontario.

A.J. Arnold : Computer Scientist, Boundary Layer Research Division.

W.F. Kobelka : Technician, Boundary Layer Research Division.

K.O. Vanek : Technician, Aerospace Meteorology Division, Meteorological Services Research Branch.

M.J. Deary : Technician, Boundary Layer Research Division (now with Application and Impact Division, Canadian Climate Centre, AES).

*Three Dark Figures
Making the Weather
In Folk, in Myth, in Legend,
A threefold test.
Shiva, Vishnu, Brahmin.
Father, Son, Holy Ghost.
Body, Mind, Spirit.
Triune, Triumvirate, Tribunal.
One is Isolate
Two is divisive
Three is Peace.
Three is Torment.
Three is Potent.
Power, Power, Power.
Air, Fire, Water.
Three Dark Figures,
Making the Weather.*

Ron Baird, Sculptor